(12) LEVEL II



NSWC TR 81-54

# FRAGMENT HAZARD INVESTIGATION PROGRAM: NATURAL COMMUNICATION DETONATION OF 155-MM PROJECTILES

by
J. G. POWELL
W. D. SMITH
F. McCLESKEY
Engineering Department

prepared for
Department of Defense
Explosives Safety Board





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NAVAL SURFACE WEAPONS CENTER

Dahlgren, Virginia 22448 Silver Spring, Maryland 20910

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This report presents the experimental findings from the detonation by means of natural communication of Army M107 155-mm projectiles (TNT-loaded) stacked in various storage configurations. Projectile stacks ranging from one to 36 pallets were detonated. The ultimate goal of the program is to provide a methodology for the determination of quantity-distance safety standards for the safe and efficient storage of explosive-filled fragment producing munitions.

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20. ABSTRACT (Continued)

In order to simplify the problem, various projectile stacks based on the standard storage pallet were detonated by means of natural communication in a series of small-scale (one pallet) fragmentation arena tests and large-scale (multiple pallet) tests designed for far-field fragment collection. A description of each test is discussed, and an analysis of the data is presented. A fragmentation model characterizing the detonation by means of natural communication of a pallet of 155-mm projectiles is presented and verified. From this model, a methodology was developed for the determination of far-field fragment hazards produced from the detonation by means of natural communication of open storage stacks of 155-mm projectiles. The significance of the methodology indicates that the quantity-distance standards for large stacks of ammunition can be determined from less expensive, less complex small-scale fragmentation arena tests.

FOREWORD

This report presents the efforts expended by the Naval Surface Weapons Center (NSWC) to generate data to improve quantity-distance standards for handling and storage of stacked munitions. The hazard classification under investigation is the mass-detonating hazard materials (Class 1, Division 1).

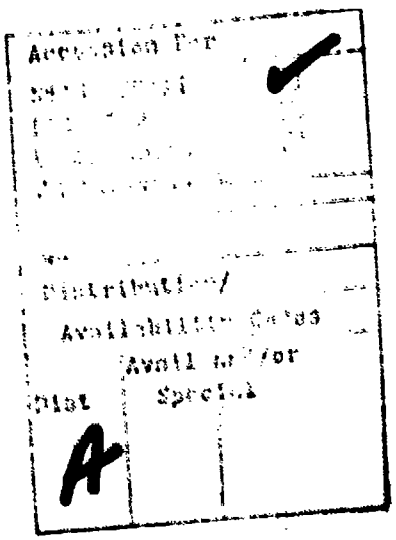
The work was accomplished for the Department of Defense Explosives Safety Board (DDESB) under Military Interdepartmental Purchase Requests CE-NSWC-78-1 of 30 June 1978 and CE-NSWC-79-1 of 22 August 1978. The technical monitor of the program for DDESB is Dr. T. A. Zaker.

This report has been reviewed and approved by J. J. Walsh, Head, Terminal Effects Branch, and R. Shank, Head, Environments Division.

Released by:

O. F. BRAXTON, Head
Engineering Department





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SI CONVERSION

| Multiply | By | To Obtain |
|---|---|---|
| feet | 30.48 | centimeters |
| inches | 2.54 | centimeters |
| grains | 0.0648 | grams |
| ft/sec | 0.3048 | meters/sec |

# INTRODUCTION

The Department of Defense Explosives Safety Board (DDESB) is conducting a continuing program to evaluate the fragment hazards produced by the accidental detonation of stored munitions. In support of this effort, the Naval Surface Weapons Center (NSWC) was funded in July 1975 to conduct the Fragment Hazard Investigation Program. The purpose of the program is to provide the DDESB with the necessary fragmentation data to improve or to substantiate the quantity-distance (QD) standards of Reference 1. Reference 1 specifies the safe and efficient storage of stacked munitions according to specific hazard classifications. The hazard class under investigation is the mass-detonating hazard materials (Class 1, Division 1). Mass-detonating items are those for which instantaneous explosion or detonation of the entire quantity may be expected in the event of an accident. Munitions of this type consist of bulk explosives and certain propellants, mines, bombs, demolition charges, torpedo and missile warheads, rockets, palletized projectiles loaded with TNT or Composition B, 8-in. and larger high-capacity projectiles loaded with explosive "D", and other munitions listed in Reference 2.

NSWC was directed by the DDESB to conduct tests with the ARMY M107 155-mm projectile (TNT-loaded), in order to permit comparison of the results with those of previous tests of large stacks of the same projectile.[3] In addition, NSWC was authorized to conduct concurrent analytical efforts in support of the test activities. The analytical studies were to be viewed as a program of continual review of experimental data and design of new tests. This combined effort was divided into three phases. Phases I and II were designed to provide the necessary fragment characterization data to develop a fragmentation model that describes the fragment hazards produced by projectile clusters that simultaneously detonate. The largest cluster of projectiles tested during Phases I and II was a single pallet of eight projectiles banded in a two-by-four matrix (standard storage configuration). These efforts have been completed, and the results are documented in an NSWC technical report.[4] Phase III was designed to investigate the fragment hazards produced from projectile clusters that detonate by means of natural communication (only one projectile primed). The data were gathered from small-scale (single pallet) detonation tests similar to those of Reference 4 and from the conduct of large-scale detonation tests (multiple pallets) designed for far-field fragment collection. These data were combined with the experimental findings from Phases I and II to validate equations previously developed[4] for the prediction of far-field fragment density.

This technical report addresses the Phase III efforts of the testing and analytical studies group. A description of the small and large-scale tests and an analysis of the far-field collection data are presented. The implications of the test results upon existing QD criteria are discussed.

## TEST AND ANALYSIS PROGRAM

### BACKGROUND

The test program was designed to be a follow-on effort of Phases I and II[4] that dealt with 155-mm projectile clusters that were simultaneously detonated. Utilizing these experimental findings, a series of tests were designed to characterize the fragment hazards produced from a projectile cluster that is detonated by means of natural communication (only one projectile is primed).

The characterization was based on close-in fragmentation data and far-field fragment collection data. The data included polar and azimuthal spatial references, and range where applicable, for fragment weights (W), numbers, velocities (V), and presented areas ($\bar{A}$).

### APPROACH

The fragmentation data required to characterize projectile clusters that detonate by means of natural communication were accumulated by conducting a series of small-scale tests followed by a series of large-scale tests. The test methods utilized throughout the test series reflect the basic test designs and definitions of Reference 5. A description of the fragment collection methods and data handling techniques are presented in Appendix A.

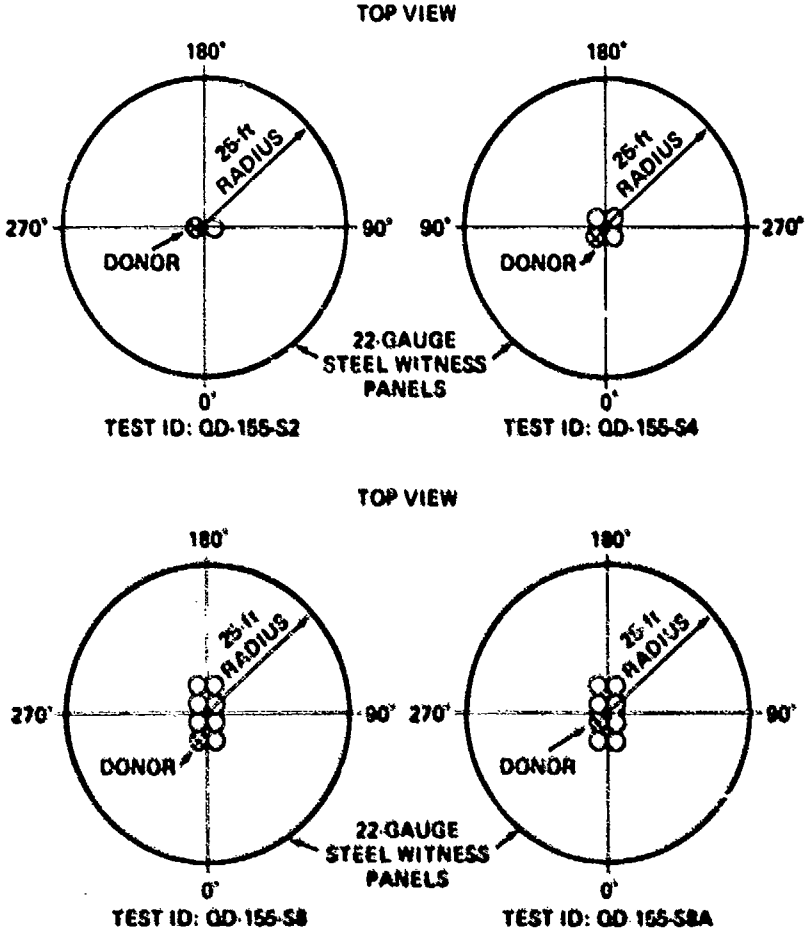
The small-scale tests were conducted at NSWC and consisted of gathering fragmentation data on projectile clusters of two, four, and eight projectiles. These projectile configurations were identical to the scenarios used in the azimuthal tests[4] and were indicative of the standard pallet design (projectile spacing 7 in. center-to-center). The detonation by means of natural communication was achieved in each projectile configuration by priming only one projectile. A Hercules Engineer's Special Blasting Cap assembled in a modified US Army M564 point-detonating (PD) nose fuze was used for the detonation. The fragmentation data were collected as a function of polar angle measured from the direction of the nose of the projectiles in a cluster with their longitudinal axis vertical.

The large-scale tests consisted of gathering far-field fragment collection data on stacks of standard shipping pallets of 155-mm projectiles that were detonated by means of natural communication. Each pallet consists of eight vertical projectiles banded in a two-by-four matrix. These tests were conducted at the White Sands Missile Range (WSMR), New Mexico, and consisted of detonating (natural communication) 1, 8, 16, and 36 pallets of projectiles.

### SMALL-SCALE TESTS

The small-scale test series began with the detonation by means of natural communication of two, four, and eight projectiles configured in the arena designs of Figure 1. Two firings of the two- and four-projectile configurations

and four firings of the eight-projectile configurations were conducted between 12 and 28 July 1977. Each configuration consisted of one donor projectile. The tests were setup to characterize the fragment patterns observed[4] in earlier tests for each of the configurations. Fragment velocities and hole count data were gathered 360° azimuthally over a polar region of 90 to 105°. High-speed motion picture cameras were used to record the fragment penetrations through 22-gauge steel witness panels. This information was used to calculate the fragment velocities. The fragment hole count data were taken from the witness panels after each test, in order to map the fragment concentrations. A list of the fragment hole count data and velocity information is presented in Appendix




NOTES

1. ALL PROJECTILES ARE VERTICAL (NOSE UP)
2. PROJECTILE SPACING 7.0 in. CENTER-TO-CENTER
3. POLAR COVERAGE 90 TO 105°
4. DRAWING NOT TO SCALE

Figure 1. Witness Panel Arena Layouts for Two-, Four-, and Eight-Projectile Configurations

## FRAGMENT CONCENTRATIONS

An analysis of the hole count data, presented in Appendix B, and the fragment velocity information (Figures 2 through 5) revealed that high-density fragment concentrations with velocities higher than a single round are forming. A close inspection of the velocity data indicates that these concentrations are similar to the ones formed from the area between adjacent projectiles (projectile interaction area) that are simultaneously detonated.[1] However, the high-velocity fragment concentrations were found to have an appreciable angular shift in the azimuthal impact points, as compared to simultaneous detonation. At the completion of the test series shown in Figure 1, the fragment hole count data showed that the azimuthal shifts were completely predictable and depended upon the primed projectile location. The angular shifts fall into three categories.

1. A shift of approximately 11° that occurs when two adjacent projectiles are nonsimultaneously detonated by a third projectile.

2. A 28° shift that results when a projectile detonates a single adjacent projectile.

3. No shift in the concentration occurs when two adjacent projectiles are simultaneously detonated by another source.

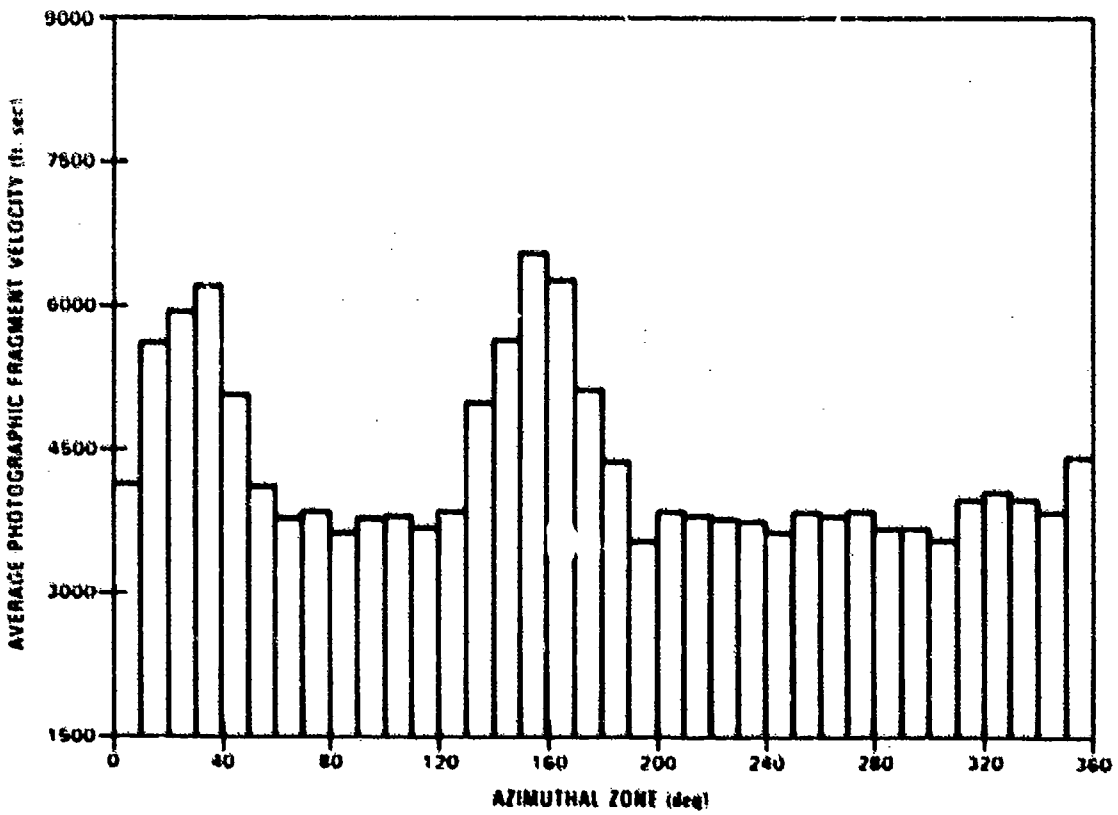



Figure 2. Average Fragment Velocities for Polar Zone 90 to 105° for Test No. QD-155-52

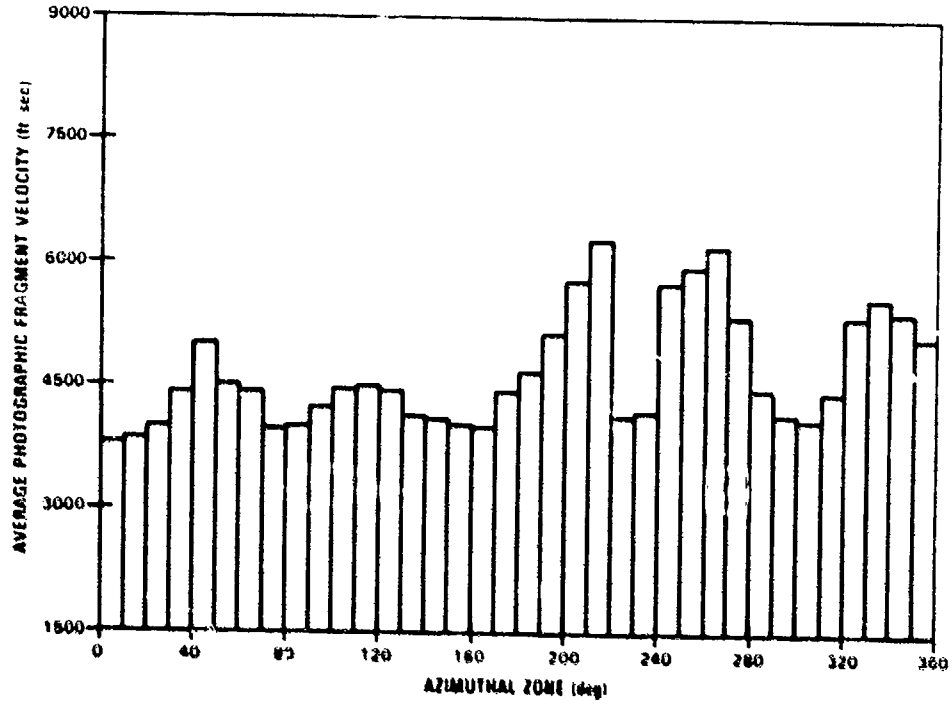



Figure 3. Average Fragment Velocities for Polar Zone 90 to 105° for Test No. QD-155-S4

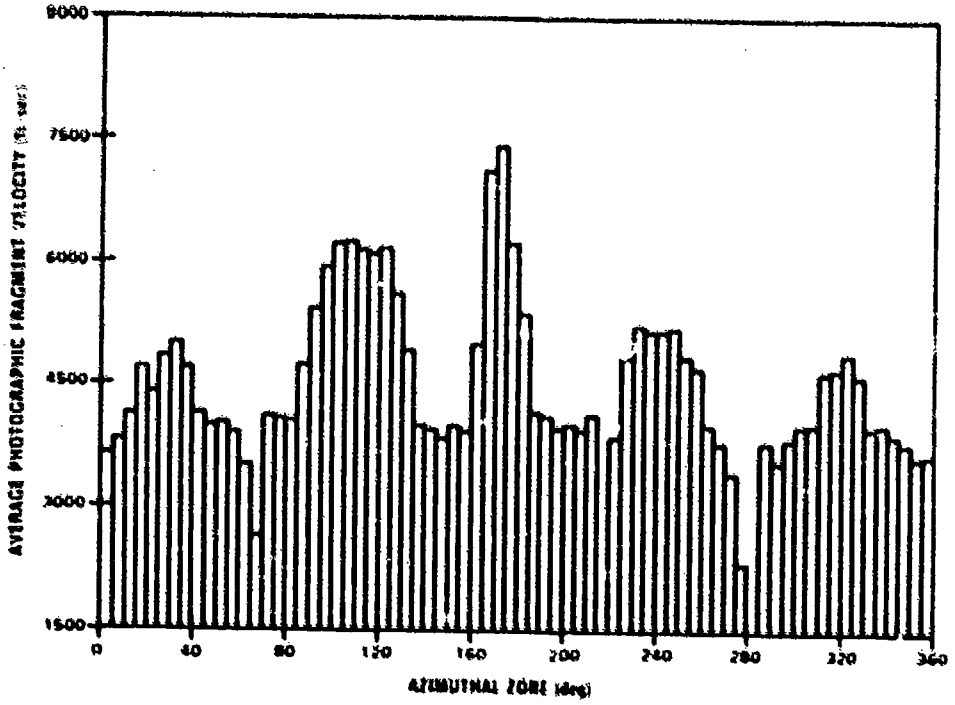



Figure 4. Average Fragment Velocities for Polar Zone 90 to 95° for Test No. QD-155-S8

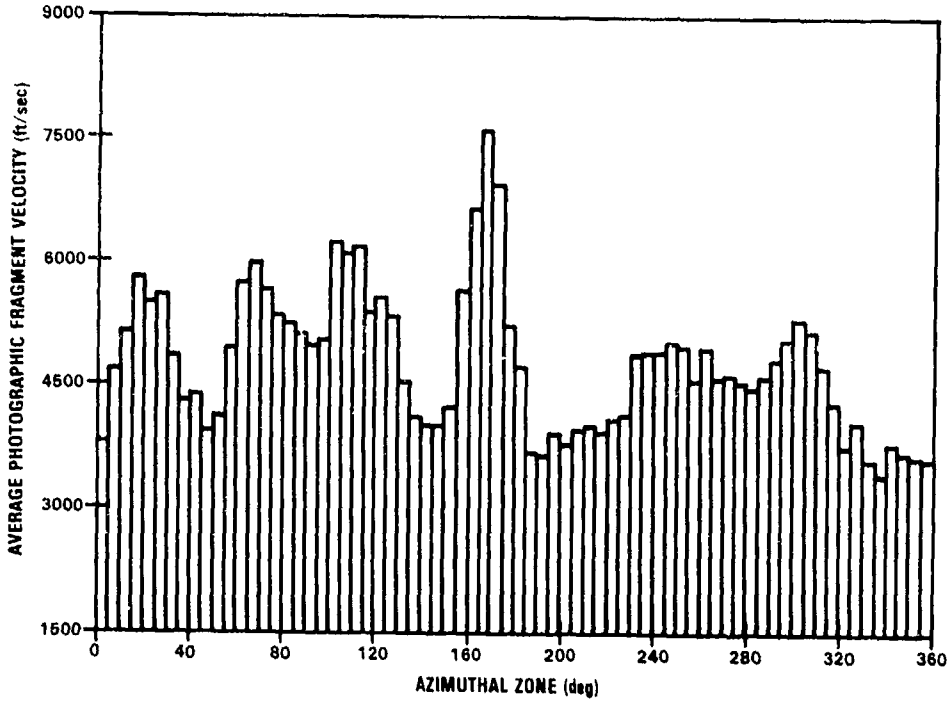



Figure 5. Average Fragment Velocities for Polar Zone 90 to 105° for Test No. QD-155-S8A

Figure 6 illustrates the concentration locations for a full-pallet detonation. The main concentration appears to come from the long side of the pallet away from the detonation source (azimuthal zone 70 to 120°). Smaller concentrations are evident at 169, 242, and 315°. Fragments from the interior of the pallet may be escaping from the 315° concentration, which is formed by the simultaneous detonation of projectile nos. 2 and 8. In order to properly characterize the fragmentation phenomena associated with the high-velocity fragment concentrations, two follow-on, small-scale fragment collection tests were conducted.

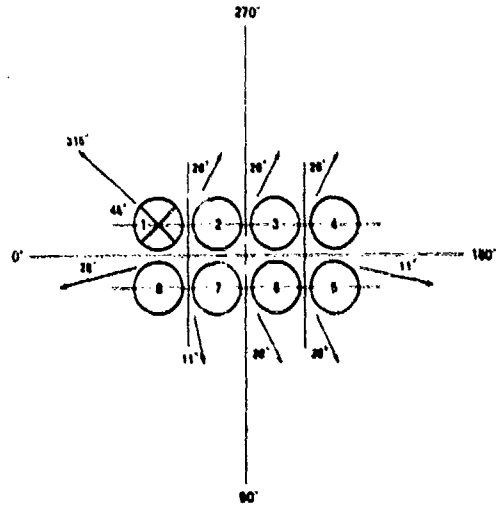



Figure 6. Fragment Concentration Locations for the Detonation of Projectile No. 1

The first fragment collection test was conducted 7 November 1977. The test consisted of the detonation by means of natural communication of four projectiles in a cube configuration. The test identification number is QD-155-SC4 and was designed to characterize the fragment-weight number distributions of the high-velocity fragment concentrations observed in the previous tests. Fragments were collected for 360° azimuthally for polar region 75 to 90°. Figure 7 is a sketch of the projectile cluster configuration positioned in the arena layout. A copy of the fragment weight-number data and average presented area data ($\bar{A}$) is presented in Appendix B.

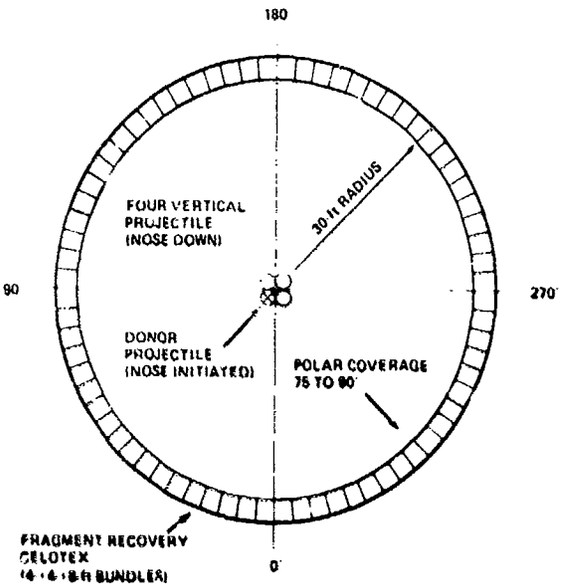
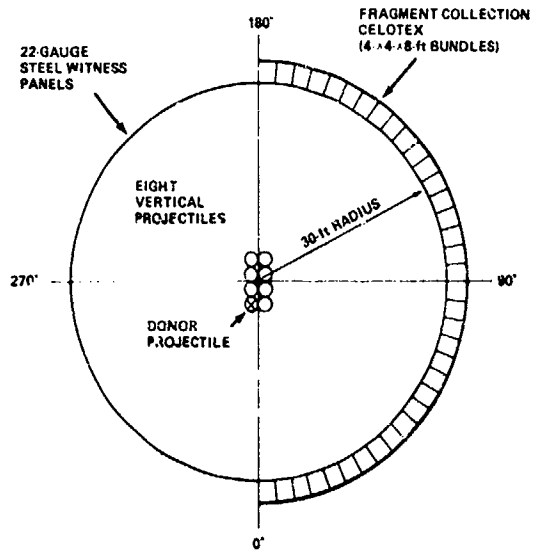



Figure 7. Arena Layout for Test No. QD-155-SC4

A full pallet of eight projectiles banded in a two-by-four vertical configuration was used for the final, small-scale fragment collection test. The test identification number is QD-155-SC12 and consists of the combined fragmentation data from three separate pallet detonations conducted 20 June 1978, 5 June 1980, and 23 July 1980. The combined data included fragment collection for 180° azimuthally for polar region 90 to 105° and 50° azimuthally for polar regions 75 to 90° and 100 to 120°. Fragment hole count data were combined to include a polar region of 85 to 120° for 180° of azimuth. Figure 8 is a sketch of the typical arena layout utilized for the three single-pallet detonations. A copy of the fragment weight-number and average presented area ($\bar{A}$) data is presented in Appendix B.




NOTES

1. WITNESS PANELS – TOTAL POLAR COVERAGE 75 TO 120° AT 5° INCREMENTS (INCLUDES 3-PALLET DETONATION)
2. PROJECTILE SPACING 7.0 in. CENTER-TO-CENTER
3. FRAGMENT COLLECTION – TOTAL POLAR COVERAGE 75 TO 120° AT 5° INCREMENTS (INCLUDES 3-PALLET DETONATION)
4. DRAWING NOT TO SCALE

Figure 8. Arena Layout for Test No. QD-155-SC12

## COMPARISON WITH SIMULTANEOUS DETONATION

The fragmentation data from the full-pallet natural-communication detonation test (QD-155-SC12) were analyzed and compared with the results of the full-pallet simultaneous detonation test (QD-155-12).[4] The analysis showed:

1. The metal in the shaded area of Figure 9 (interior casing) does not enter into the fragment distribution but is instead trapped within the interior area. This was proven for the simultaneous detonation of a pallet[4] and can be shown for natural communication detonation by comparing the total fragment weights recovered for both types of detonation. For example, the total metal weight recovered from polar zone 90 to 95° (0 to 180° azimuth) for the natural communication detonation test was 99105.2 grains. The total fragment weight recovered from the same polar zone and azimuthal angles for the simultaneous detonation of a pallet was 99246.4 grains. Similarly, the total metal weight from polar zone 95 to 100° (0 to 180° azimuthal) was 213197.6 grains for QD-155-SC12 and 229743.8 grains for QD-155-12. Therefore, there is no indication of a contribution to the interaction area on the long side of the pallet from the interior of the pallet as a result of natural communication detonation.

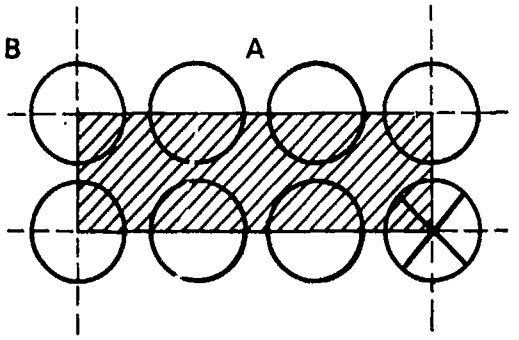



Figure 9. Fragments are Trapped within the Shaded Area

2. Fragments from the interaction area on the long side away from the primed projectile will be concentrated in a beam approximately 45° wide azimuthally as compared to 20° wide azimuthally for simultaneous detonation. A comparison of these data is presented in Figure 10. Furthermore, the total fragment weight recovered from the interaction area for simultaneous detonation (polar zone 90 to 100°) and natural communication detonation (polar zone 90 to 105°) is 170315.0 and 163745.5 grains, respectively. This indicates that the polar spread of the fragment concentration is 5° wider than simultaneous detonation.

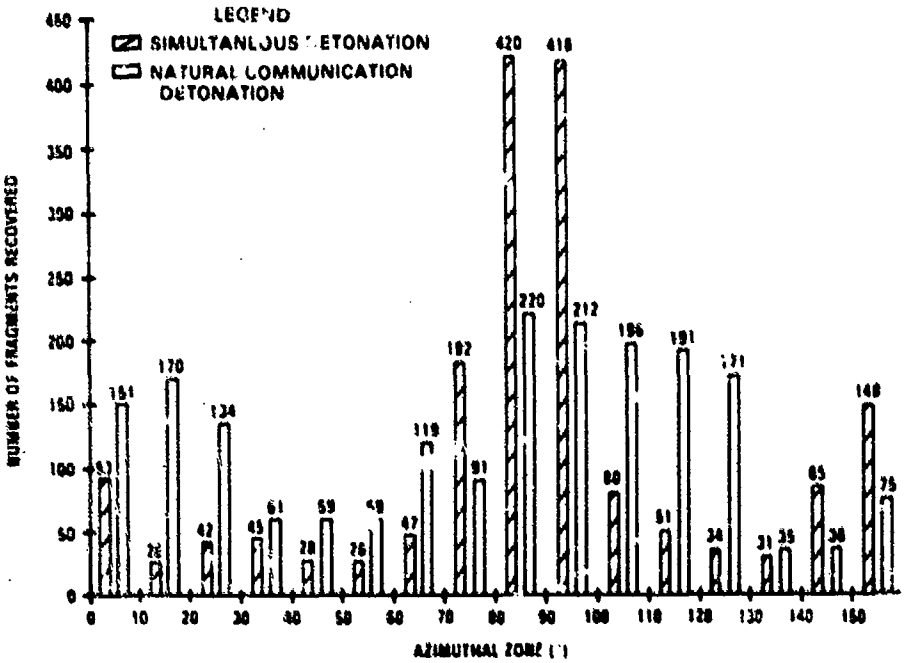



Figure 10. Fragment Distribution

3. The slope of the weight-number distribution (Mott Plot) for the interaction area fragments approximates the slope of the Mott Plot for interaction area fragments from the simultaneous detonation of a pallet. Figure 11 presents a comparison of the Mott Plot for interaction area fragments from each detonation scheme. The similarity of the slopes of a first-order, least-squares fit to the data is apparent.

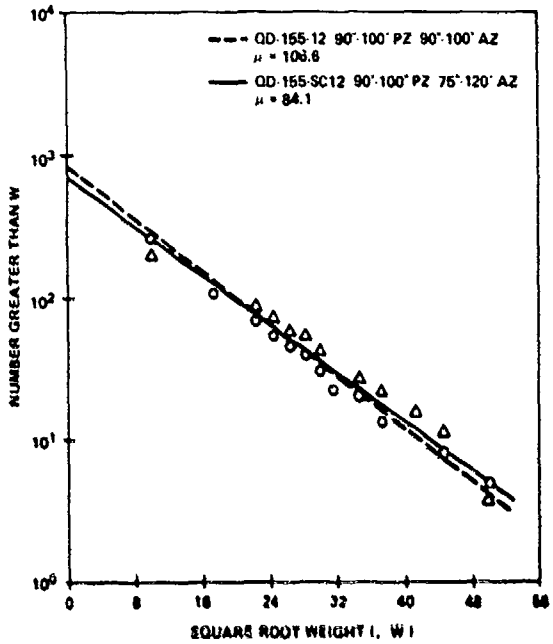



Figure 11. Fragment Weight-Number Distribution for Natural Communication Detonation of a Pallet of 155-mm Projectile (QD-155-SC12)

4. The ballistic efficiency of fragments from the interaction area is similar to the ballistic efficiency of fragments from the interaction area for the simultaneous detonation of a pallet. Reference 4 shows that a measure of fragment ballistic efficiency is provided by analyzing the distribution of the number of fragments as a function of gamma ($\bar{A}/W$). Figure 12 presents a comparison of this distribution for interaction area fragments from the detonation of a pallet by both detonation schemes. The slopes of a least-squares fit to the data are quite similar, which indicates that the distribution of gamma is equivalent for both types of detonation.

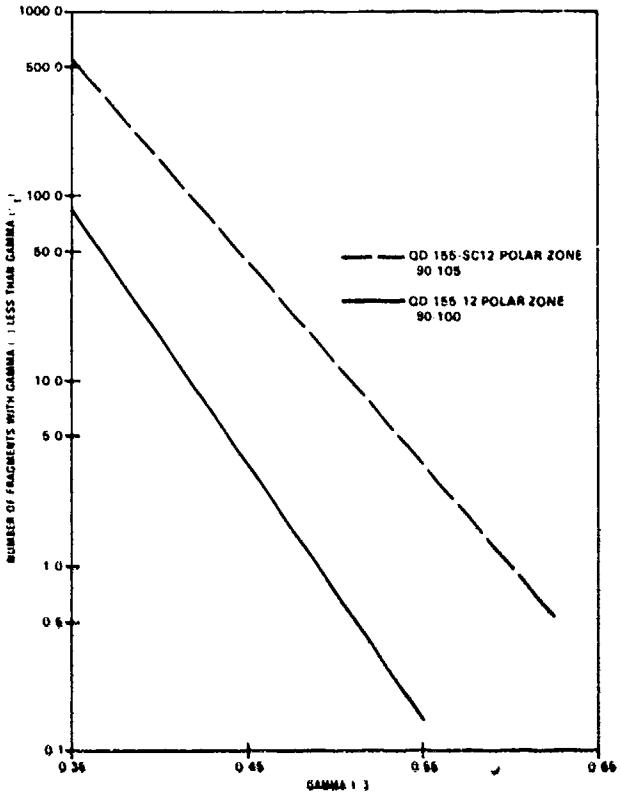



Figure 12. Gamma Distribution for Simultaneous Detonation (QD-155-12) and Natural Communication Detonation (QD-155-SC12) of a Pallet

## SUMMARY

To summarize, the significant difference between natural communication and simultaneous detonations of a pallet of 155-mm projectiles is in the angular width and velocity of the fragment concentrations produced from the pallet interaction areas. The natural communication detonation produces a wider concentration that is less densely packed with fragments traveling at a lower velocity than those produced by simultaneous detonation. The Mott Plot and gamma distribution parameters characterizing the fragment concentrations are equivalent for both types of detonation.

These data imply that the fragment concentrations from the pallet interaction area possess the greatest potential to produce far-field fragments. However, empirical data were not available to indicate that similar fragment concentrations would occur as the result of the detonation of a multiple-pallet stack. Therefore, the detonation of multiple-pallet stacks was necessary to obtain the far-field fragment data necessary to evaluate empirical relations previously developed[4] using small-scale test data.

## LARGE-SCALE MULTIPLE-PALLET TESTS

The large-scale, multiple-pallet detonation tests were designed based upon the fragment patterns characterized in the small-scale fragmentation arena tests. These tests were conducted at WSMR on the Dice Throw test site from August 1979 to March 1980. Approximately 255 acres of high-elevation desert were bladed clear of foliage and surveyed according to range and azimuthal location for far-field fragment collection. Blast overpressure data were also measured for each test. Blast gages were located on two perpendicular lines at distances corresponding to peak overpressures of 40, 10, 4, and 1 psi from a TNT hemisphere of the same weight as the net explosive content of the projectiles. Figure 13 shows the far-field fragment collection area, the blast gauge locations, the stack configuration, and the donor projectile location for the single-pallet configuration.

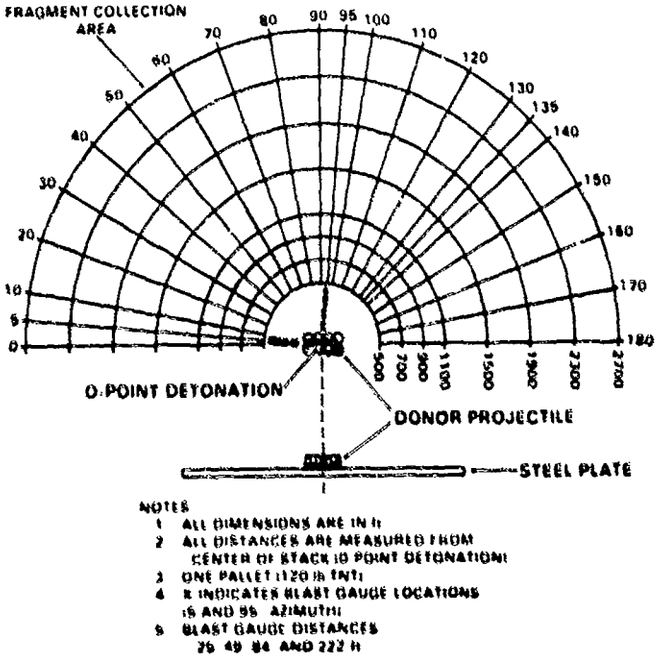



**Figure 13. Test Configuration for the Natural Communication Detonation of a Pallet of 155-mm Projectiles**

The single-pallet configuration was the first configuration detonated in the large-scale series. The test consisted of eight separate pallet detonations. At the completion of the last firing, the far-field fragments were collected by hand pickup.

The follow-on sequence of tests consisted of an 8-pallet detonation, two 16-pallet detonations, and a 36-pallet detonation. Figures 14 through 16 are sketches of the test layout and donor projectiles' locations for each of the stack configurations.

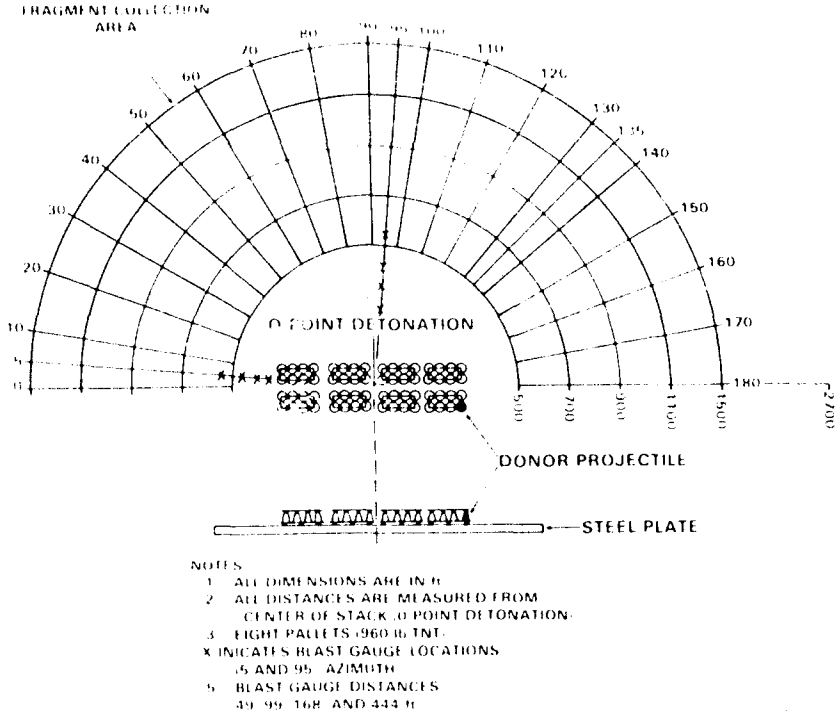



Figure 14. Fragment Collection Area for the Detonation of Eight Pallets of 155-mm Projectiles

## FRAGMENT CONCENTRATIONS

The first step in the analysis of the large-scale, multiple-pallet test data was to count the number of the fragments recovered from each angular recovery sector between the ranges of 500 and 2700 ft. The detailed data are presented in Appendix B. The data plotted in Figures 17 through 19 show that the fragment concentrations are forming at the positions (70 to 120° azimuth) observed for the single-pallet test (QD-155-SC12). Furthermore, from the data presented in Table 1, the number of fragments in the fragment concentration is directly related to the number of interaction areas ($N_{IA}$) in the stack, since the calculated number of fragments per interaction area is essentially constant for each stack size.

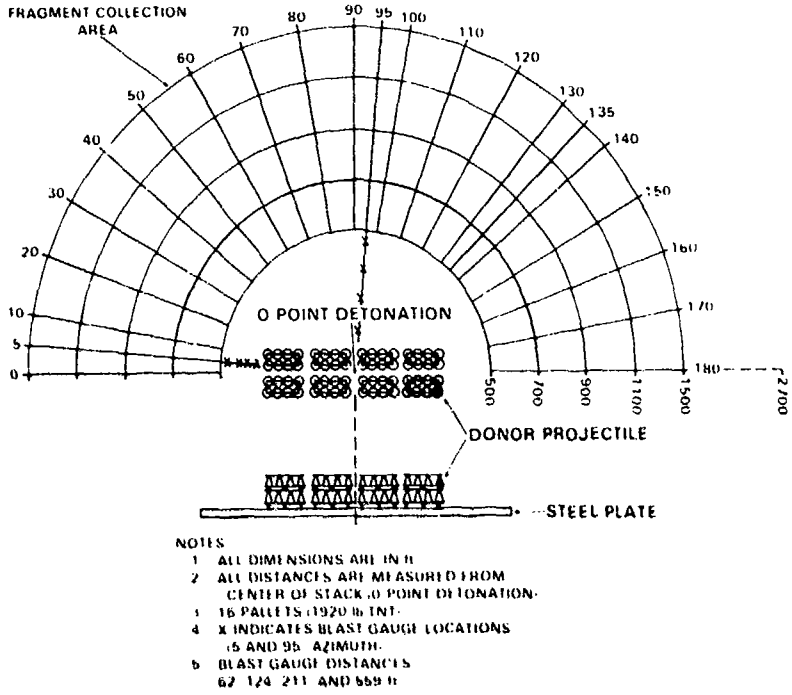



Figure 15. Fragment Collection Area for the Detonation of 16 Pallets of 155-mm Projectiles

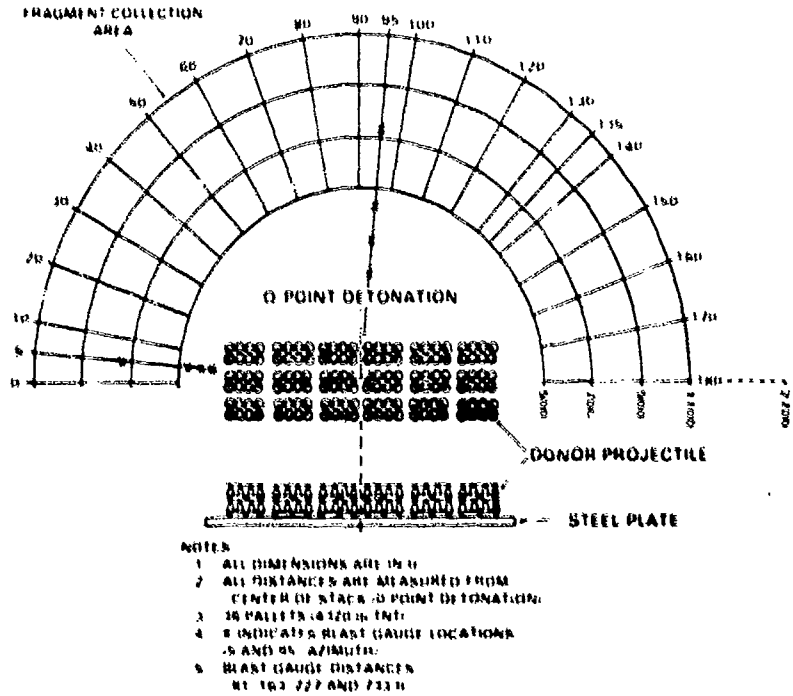



Figure 16. Fragment Collection Area for the Detonation of 36 Pallets of 155-mm Projectiles

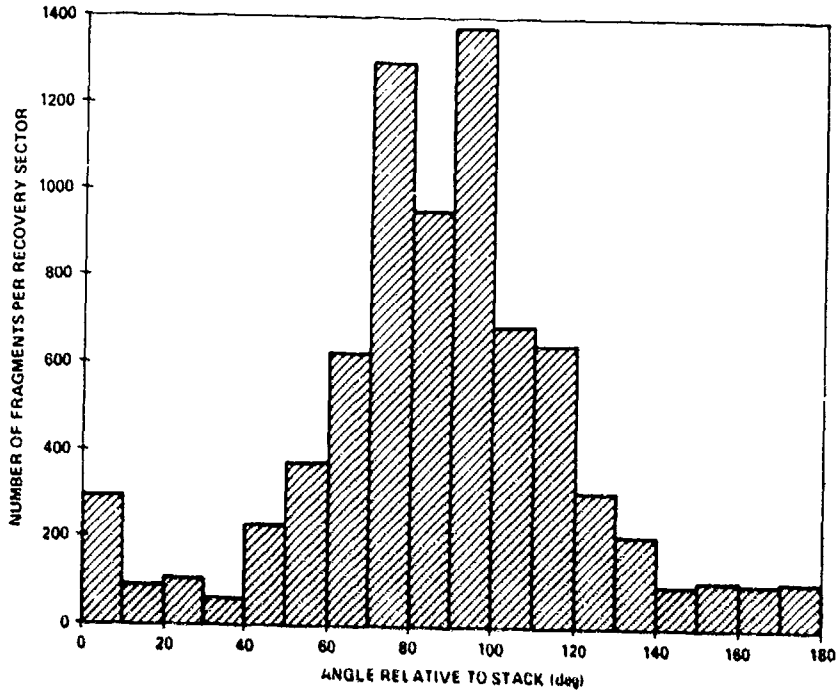



Figure 17. Total Number of Fragments Recovered per Recovery Sector for 8-Pallet Detonation Test

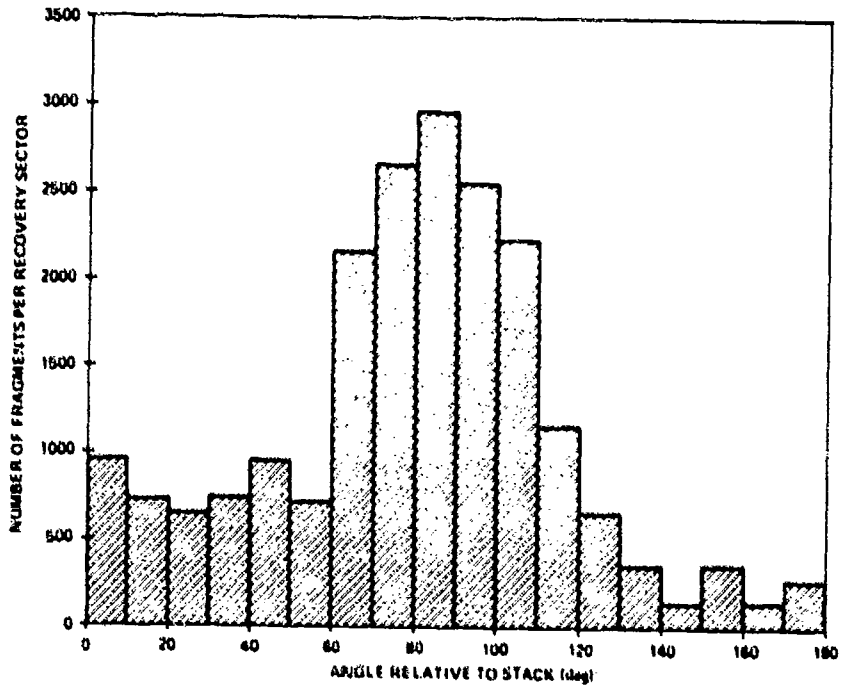



Figure 18. Total Number of Fragments Recovered per Recovery Sector for 16-Pallet Detonation Test

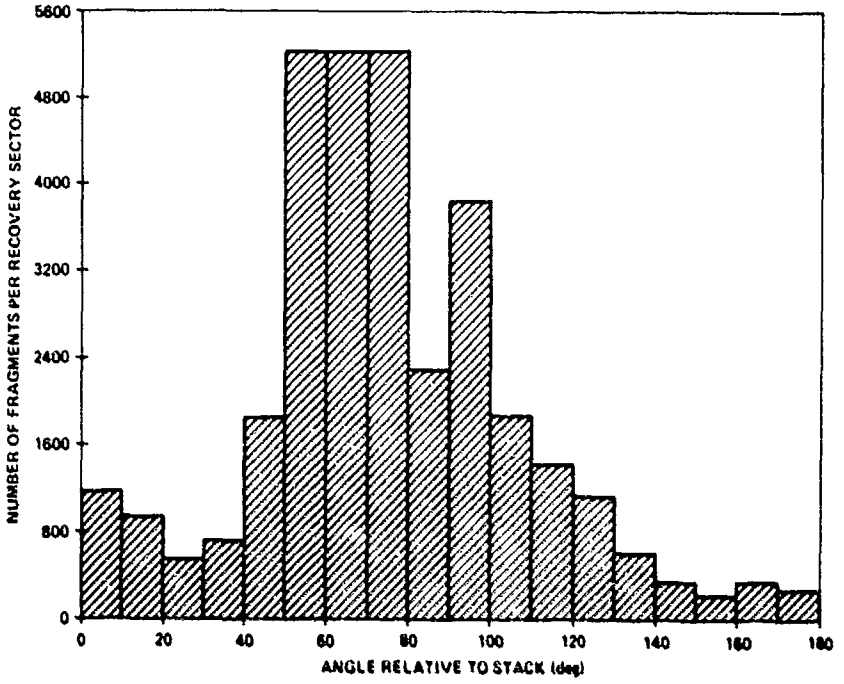



Figure 19. Total Number of Fragments Recovered per Recovery Sector for 36-Pallet Detonation Test

Table 1. Number of Fragments in Fragment Concentrations Related to Number of Interaction Areas ($N_{IA}$) in Stack

| Stack Size (Pallets) | $N_{IA}$ | Recovery Sector (°) | Total No. Fragments | No. Fragments per Interaction Area |
|---|---|---|---|---|
| 8 | 15 | 90 to 100 | 1390 | 92.7 |
| 16 | 30 | 90 to 100 | 2545 | 84.8 |
| 36 | 46 | 90 to 100 | 3850 | 83.7 |

## FRAGMENT WEIGHT-NUMBER DISTRIBUTION (MOTT PLOT)

The second step in the analysis of the multiple-pallet test data was to weigh and sort the recovered fragments, in order to produce the weight-number distribution (Mott Plot). The tremendous quantity (numbers and weight) of fragments recovered from the multiple-pallet detonation test made it impractical to weigh and sort each and every fragment. It was decided to process just the fragments recovered from azimuthal zones that correspond to the fragment concentrations. The detailed data for these zones for each test are contained in Appendix B.

Figure 20 presents the Mott Plot for the azimuthal sector of 90 to 95° and the range of 500 to 2700 ft for the three multiple-pallet detonations (8, 16, and 36 pallets). The slopes of a first-order, least-squares fit to the data for each test are quite similar. The data and a least-squares fit for the single-pallet natural communication detonation test (azimuthal zone 90 to 95°, polar zone 90 to 120°) are presented for comparative purposes. As can be seen, the slope of the fit to these data are also similar to those of the multiple-pallet detonation. This is further confirmation that the fragments from the multiple-pallet detonation tests are similar in weight and number to the fragments from the single-pallet natural communication detonation.

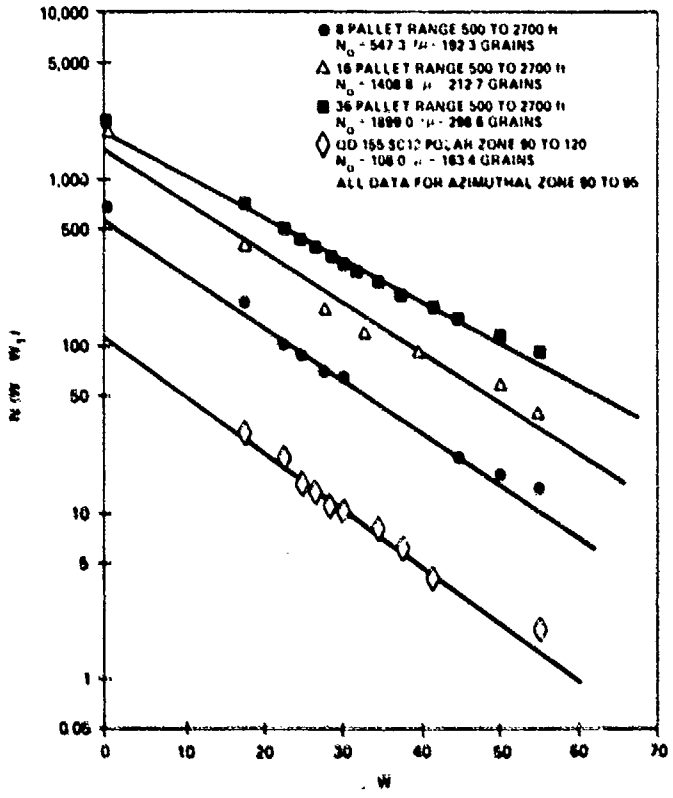



Figure 20. Mott Plot Comparison for Multiple-Pallet Detonation Tests and Single-Pallet Arena Test

FRAGMENT BALLISTIC EFFICIENCY

The fragments that were processed to produce the Mott Plots had their presented areas measured, in order to evaluate their ballistic efficiency. As previously mentioned, a good measure of fragment ballistic efficiency is provided by the distribution of the number of fragments as a function of gamma (A/W). Figure 21 presents these data for the three multiple-pallet detonation tests (azimuthal zone 90 to 95°, range 500 to 2700 ft) and the single-pallet natural communication detonation test (QD-155-SC12). The slopes of a first-order, least-squares fit to the data for each test are similar and is a further confirmation that the fragments from the multiple-pallet detonations are identical to the fragments from the single-pallet natural communication detonation.

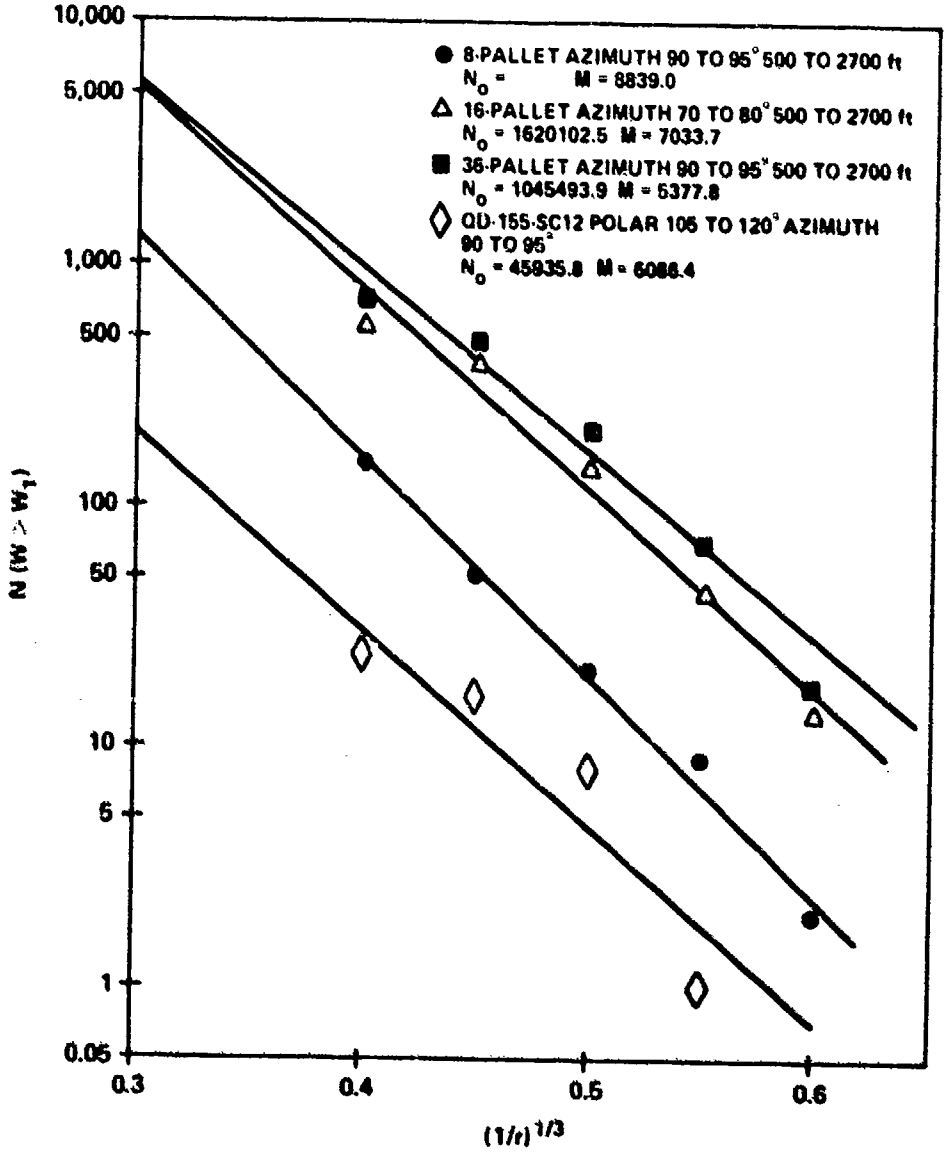



Figure 21. Gamma Distribution

AIR BLAST OVERPRESSURE

The peak air blast overpressure data contained in Appendix B are presented graphically in Figure 22 as a function of range. Also shown for comparative purposes are the existing blast criteria (40 $W^{1/3}$) that corresponds to a peak overpressure of approximately 1.2 psi.[6] Table 2 compares the range at which 1.2 psi occurs for each stack configuration to the 40 $W^{1/3}$ range. The existing criteria overestimate the actual 1.2-psi range.

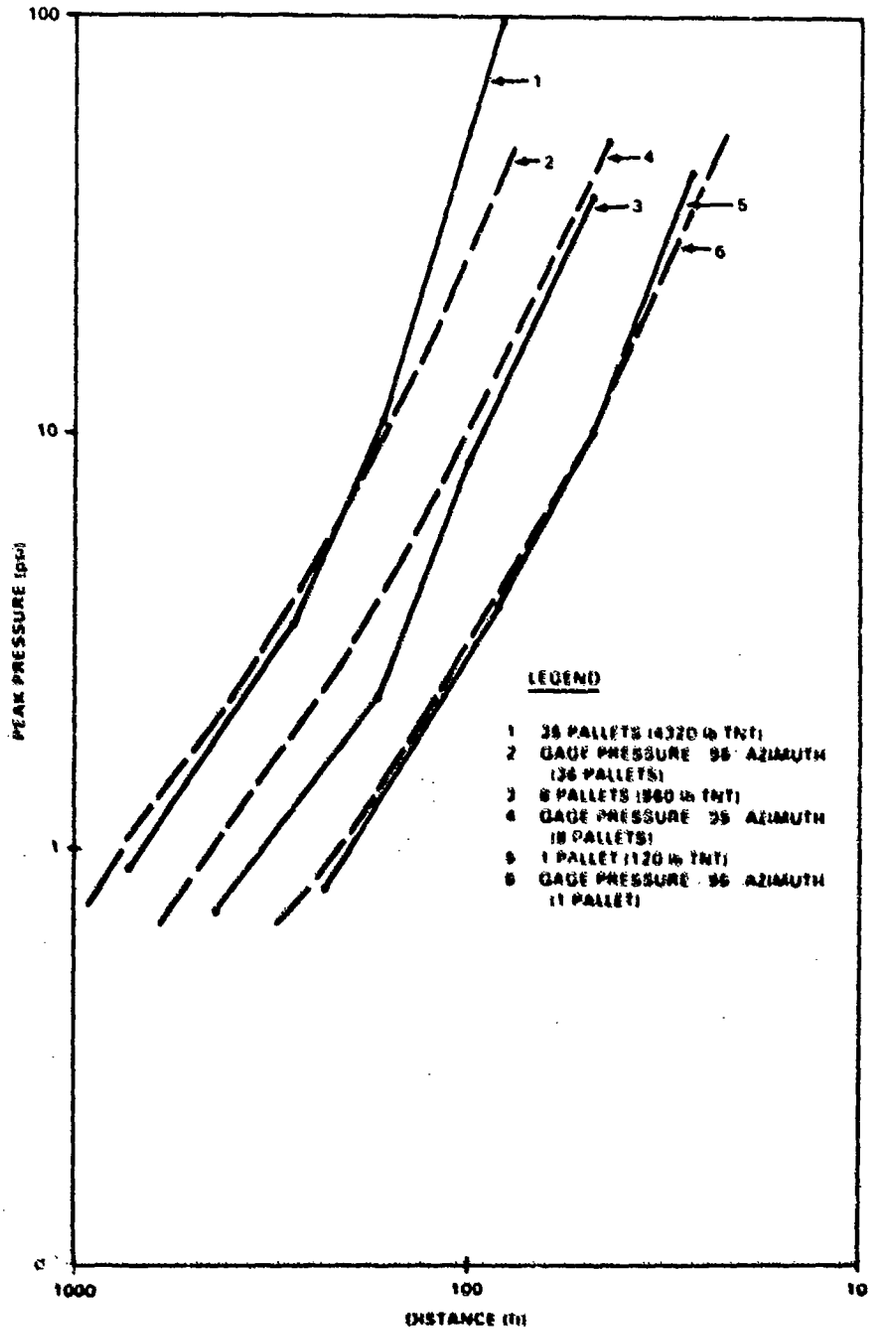



Figure 22. Peak Air Blast Overpressure Data

Table 2. Estimated 1.2-psi Ranges and Existing QD Criteria (40 $W^{1/3}$) for Stack Configuration

| Stack Size (Pallets) | Multiple-Pallet Detonation Net Explosive (Wt/lb) | Range (ft) 95° Array | Range (ft) 40 $W^{1/3}$ |
|---|---|---|---|
| 1 | 120 | 170 | 197 |
| 8 | 960 | 275 | 395 |
| 36 | 4320 | 620 | 651 |

SUMMARY

The multiple-pallet detonation tests showed that the pallet interaction areas produce significant quantities of far-field fragments. The number of fragments recovered as a function of range for the 8-, 16-, and 36-pallet (90 to 95° azimuth) tests is presented in Figures 23 through 25. Also shown is the existing fragment criteria (1/600 $ft^2$). The range at which the fragment density falls below the existing criteria is compared to the QD criteria (40 $W^{1/3}$) in Table 3. It is apparent that the existing QD criteria underestimates the fragment hazard for the stack configuration tested.

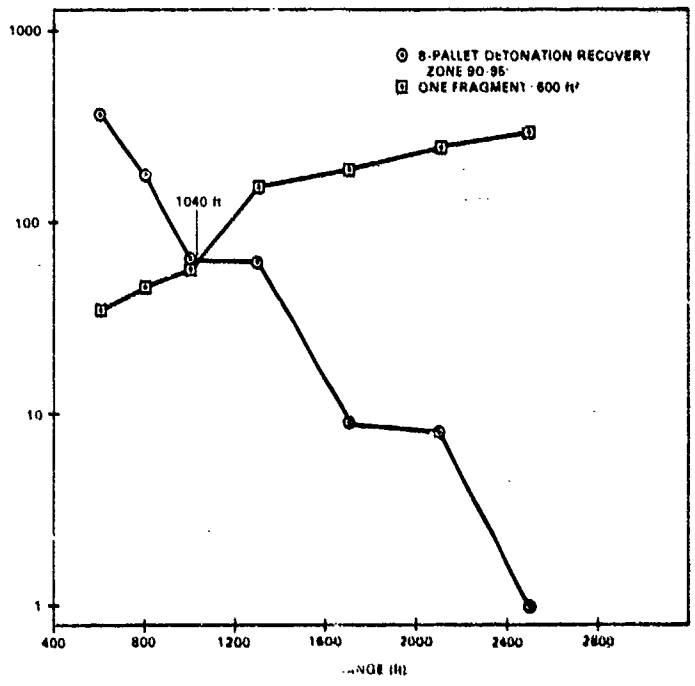



Figure 23. Comparison of Recovery Data to Hazardous Fragment Criteria for 8-Pallet Detonation

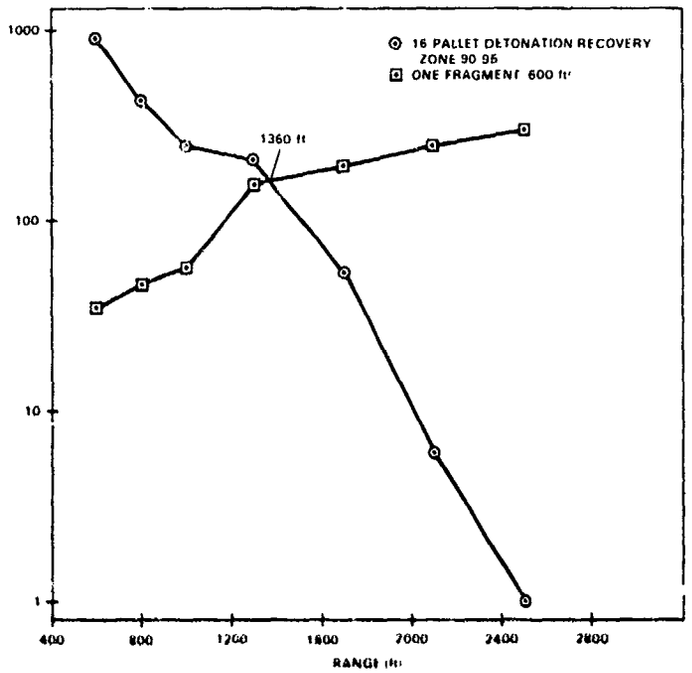



Figure 24. Comparison of Recovery Data to Hazardous Fragment Criteria for 16-Pallet Detonation

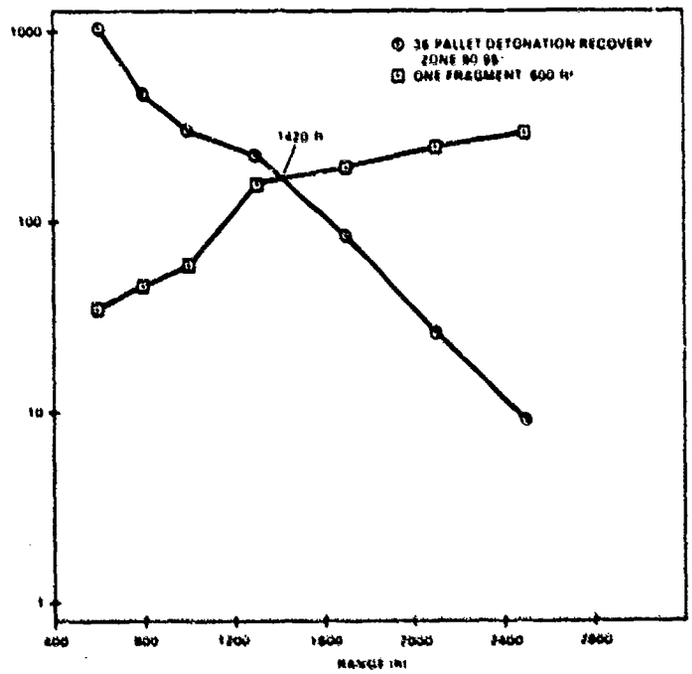



Figure 25. Comparison of Recovery Data to Hazardous Fragment Criteria for 36-Pallet Detonation

Table 3. Range at Which Fragment Density Falls Below 1/600 $ft^2$ Compared to QD Criteria (40 $W^{1/3}$)

| Stack Size | 1/600 $ft^2$ | Range (ft) 40 $W^{1/3}$ |
|---|---|---|
| 8 | 1040 | 197 |
| 16 | 1360 | 395 |
| 36 | 1420 | 651 |

## ANALYTICAL STUDIES

The far-field fragment data collected from the multiple-pallet detonation tests indicate that the QD criteria may not be adequate for the specific stack configurations tested. However, the goal of the program is to develop a capability to predict fragment density as a function of stack configuration and size. This section describes the results of recent studies in the area of fragment trajectory and the refinement of the empirical relations developed during Phases I and II[4] using the small- and large-scale test data.

## FRAGMENT RANGE INVESTIGATION

The following section presents a discussion of the implications upon fragment range of recent research conducted to further define the subsonic and supersonic drag coefficients of typical fragments.

## FRAGMENT DRAG COEFFICIENT ($C_D$)

Two experimental fragment drag programs have been conducted. The first program discussed in Reference 7 was conducted in the vertical wind tunnel at the Edgewood Area of the Aberdeen Proving Ground to determine the drag coefficient of 58 fragments collected from the simultaneous detonation of 155-mm projectiles. The fragments were divided into five characteristic shapes and, as expected, there was a subsonic $C_D$ to shape correlation. Figure 26 presents a summary of the results. The maximum to minimum variations (dispersions) in $C_D$ for all five shapes (±0.24) compare favorably with the ±0.2 dispersion obtained for 105-mm projectile and 120-mm mortar projectile fragments reported in Reference 8. The only surprise was the large difference in mean values for the five shapes. Previous results[8] had shown that the mean values were equivalent for the two projectiles.

The second fragment drag program was conducted with MARK 81 bomb fragments in the Aeroballistic Research Facility at Eglin AFB, Florida. Approximately 100 fragments were tested at mach numbers ranging from 0.67 to 3.66.* The fragments were divided into nine different shapes, and again there was an

* James W. McDonald, "Bomb Fragments," Eglin Air Force Base, 23 September 1980.

evident correlation between $C_D$ and shape. Only 11 fragments were tested at subsonic conditions, and the $C_D$ varied from 0.68 to 1.61. Supersonic $C_D$ varied from 0.76 to 2.98.

COPPER BAND

CHARACTERISTICS : SMOOTH, ROUNDED SURFACE
DENSE
FLAT BOTTOM
RANGE OF $C_D$ : 1.44 TO 1.11
STANDARD DEVIATION: 0.108
MEAN VALUE : 1.268

BOX PLATEAU

CHARACTERISTICS : LARGE PORTION OF BOTH SIDES OF FRAGMENT IS FLAT
FLAT SECTIONS ARE SMOOTH
NO GENERAL OVERALL SHAPE
RANGE OF $C_D$ : 1.59 TO 1.211
STANDARD DEVIATION: 0 149
MEAN VALUE : 1.433

PARALLEL PIPED

CHARACTERISTICS : LARGE PORTIONS OF BOTH SIDES ARE FLAT AND SMOOTH
OVERALL RECTANGULAR SHAPE
RANGE OF $C_D$ . 2.07 TO 1.34
STANDARD DEVIATION: 0.2829
MEAN VALUE : 1.707

MOUNTAIN RIDGE

CHARACTERISTICS : FLAT BOTTOM
FORMS A RIDGE AT TOP
RANGE OF $C_D$ : 1 39 YO 0.85
STANDARD DEVIATION: 0 166
MEAN VALUE : 1.132

WEDGES

CHARACTERISTICS : TRIANGULAR SHAPE
TWO OF THE THREE SURFACES ARE GENERALLY SMOOTH
RANGE OF $C_D$ : 0.818 TO 1.01
STANDARD DEVIATION: 0 155
MEAN VALUE : 0.812

Figure 26. Fragment Types

These new data were combined to produce the minimum, average, and maximum $C_D$ curves for bomb and projectile fragments (Figure 27). For comparison, the average $C_D$ curves contained in References 4 and 9 are shown as dashed lines. It is assumed that at least 95% of all bomb and projectile fragments will have a $C_D$ between the minimum and maximum limits shown.

A fragment that travels to the far-field spends the majority of its flight time at subsonic velocity. Consequently, the accuracy of the value used for the subsonic drag coefficient is critical to the accuracy of a range calculation. Also significantly affected by the subsonic $C_D$ is the impact velocity ($V_F$) of the fragment and, therefore, its terminal kinetic energy (KE). Table 4 presents the results of a particle trajectory calculation for a "typical" 155-mm fragment; for example, ($W = 1350$ grains, $V_o = 6500$ ft/sec, $\alpha = 20°$, $\gamma = 8 \frac{in.^2}{lb}$) using the minimum, average, and maximum $C_D$ curves presented in Figure 26.

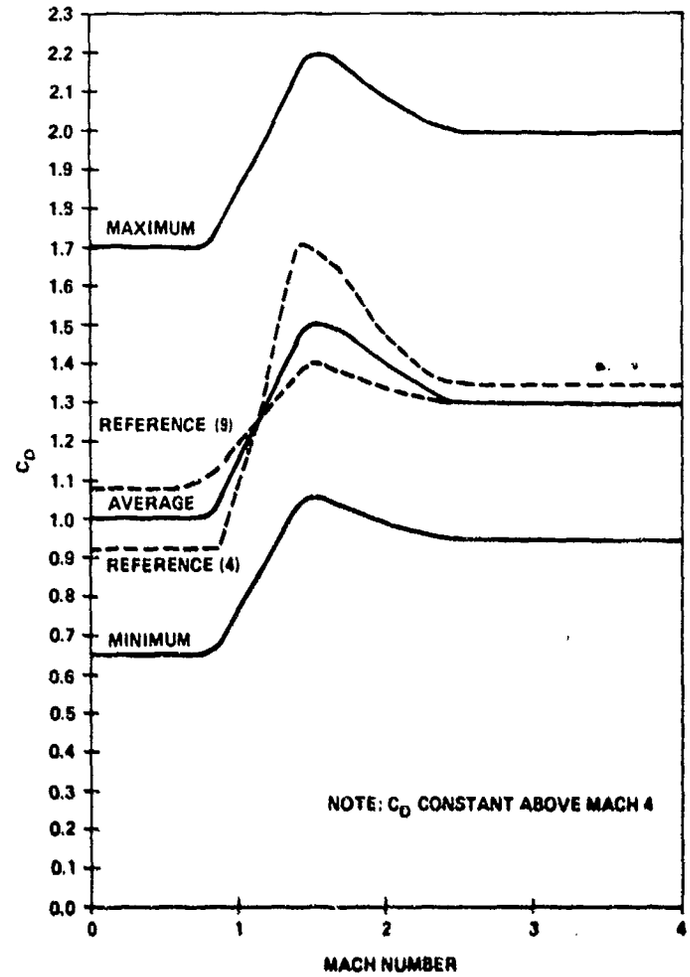



Figure 27. Coefficient of Drag Versus Mach Number

Table 4. Results of a Particle Trajectory Calculation Using $C_D$ Curves

| $C_D$ Curve | Range (ft) | $V_F$ (ft/sec) | Final (Impact) KE (ft/lb) |
|---|---|---|---|
| Minimum | 2790 | 141 | 60 |
| Average | 1980 | 115 | 40 |
| Maximum | 1285 | 90 | 24 |

The $C_D$ uncertainty for any one fragment shape will only be about one-half the minimum to maximum $C_D$ difference. Assuming that the fragment used above has mean $C_D$ equal to the average $C_D$ and a variation around the average ±0.25 $C_D$, the following effects are obtained in Table 5.

Table 5. Results of a Particle Trajectory Calculation Using Average $C_D$ Curve ±0.25

| $C_D$ Curve | Range (ft) | $V_F$ (ft/sec) | Final (Impact) KE (ft/lb) |
|---|---|---|---|
| $C_{DAvg}$ -0.25 $C_{DAvg}$ | 2470 | 132 | 52 |
| $C_{Davg}$ | 1980 | 115 | 40 |
| $C_{DAvg}$ +0.25 $C_{DAvg}$ | 1650 | 104 | 32 |

The effect upon range and KE is still significant. The gamma data from the large-scale, multiple-pallet detonation tests were analyzed to determine which $C_D$ curve should be used for range calculations. The data indicated that the mean $C_D$ is most representative of the "typical" 155-mm, far-field fragment.

## DEVELOPMENT OF EMPIRICAL RELATION

The development of an empirical relation to predict fragment density in the far-field for a general weapon stack configuration is discussed in this section. The relation is developed from the following equations.

## NUMBER OF FRAGMENTS

It was shown in Reference 4 that a good representation for 155-mm projectile fragments is provided by

$$N(\gamma<\gamma_1) = N_0 e^{-\left(\frac{M}{\gamma_1}\right)^{1/3}} \qquad (1)$$

where

$N(\gamma<\gamma_1)$ = number of fragments with $\gamma$ less than a specified gamma ($\gamma_1$)

$N_0$ = constant that is equal to the number of fragments with $\gamma$ less than infinity, or equally, the number of fragments with weight greater than zero. It is the theoretical total number of fragments including predicted fragments that are the size of dust particles. $N_0$ is not the number of fragments collected.

$-M^{1/3}$ = slope of the straight line relationship when plotted on semilogarithmic paper against $\left(\frac{1}{\gamma_1}\right)^{1/3}$

$\gamma$ = average presented area to weight ratio of the fragments ($in.^2/lb$)

$\gamma_1$ = represents any specified value of $\gamma$

Since $N_0$ in Equation (1) is developed from arena test data, it is based on more than a 1° azimuthal zone and more than one fragment interaction area ($N_{IA}$) and will have to be corrected and a new variable redefined as,

$$N_{0A} = \frac{N_0}{(Deg_{AZ})(N_{IA})} \tag{1a}$$

where

$N_{0A}$ = the theoretical total number of fragments for 1° azimuthal zone and for one interaction area

$Deg_{AZ}$ = the number of degrees in the azimuthal zone used to calculate $N_0$

$N_{IA}$ = number of interaction areas in the small-scale arena test used to compute $N_0$

Equation (1) reduces to

$$N(\gamma<\gamma_1) = N_{0A} e^{-\left(\frac{M}{\gamma_1}\right)^{1/3}} \tag{1b}$$

for 1° of azimuth and one interaction area.

To be useful for density calculations, Equation (1b) must be expressed in terms of range. Using a particle trajectory program, the following relation can be established:

$$\gamma = aR^b \tag{2}$$

or

$$R = \left(\frac{\gamma}{a}\right)^{\frac{1}{b}} \tag{2a}$$

where

R = range (ft)

a,b = constants developed based upon fragment velocity, drag coefficient and ejection angle (b is always negative)

Substituting Equation (2) into Equation (1b) yields

$$N(R>R_1) = N_{0A} e^{-\left(\frac{MR_1^{-b}}{a}\right)^{1/3}} \tag{1c}$$

where

$N(R>R_1)$ = number of fragments with range greater than $R_1$.

In order to consider more than one interaction area, $N_{IA}$ is introduced into Equation (1c) to yield

$$N(R>R_1) = N_{0A} N_{IA} e^{-\left(\frac{MR_1^{-b}}{a}\right)^{1/3}} \tag{3}$$

where $N_{IA}$ is equal to the number of projectiles in the side of the stack facing the target area (one tier) -1, multiplied by the number of tiers.

The desired relation is for the number of fragments between ranges $R_1$ and $R_1 + dR$. Referring to Figure 28, the required number of fragments (dN) is the difference between $N(R>R_1)$ and $N(R>R_1 + dR)$. It may also be written

$$dN = \tan\theta \, (dR) \tag{4}$$

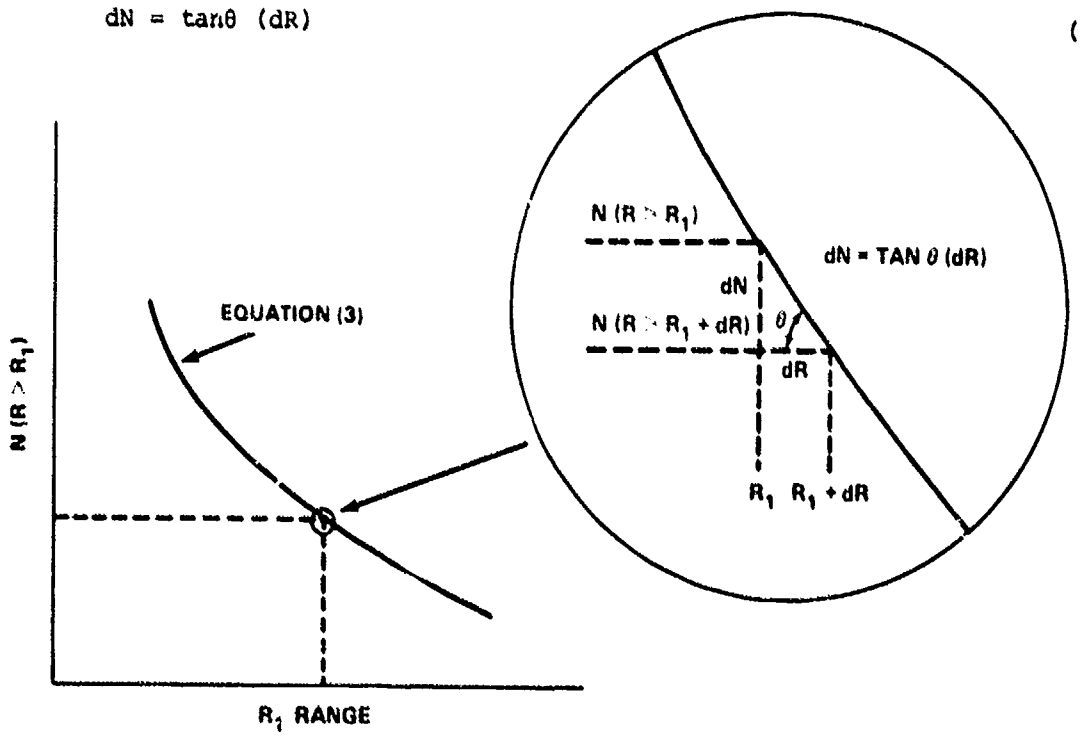



Figure 28. Calculation of dN

By definition, the derivative of Equation (3) is equal to the slope ($\tan\theta$) of the function at any range $R_1$. Taking the derivative of Equation (3) and substituting it for $\tan\theta$ in Equation (4) yields

$$dN = \left[ \left(\frac{-b}{3}\right)\left(\frac{M}{a}\right)^{1/3} R^{-\left(\frac{a}{3}+1\right)} \right] N_{OA} N_{IA} e^{-\left(\frac{MR^{-b}}{a}\right)^{1/3}} dR \qquad (4a)$$

where

dN = number of fragments between ranges R and R + dR

R = range (subscript no longer needed)

$a, b, M, N_{OA}, N_{IA}$ = constants previously described

FAR-FIELD AREA

The far-field area into which the fragments fall is based upon a 1° azimuthal sector shown in Figure 29. It can be shown for this area that

$$dA = 0.01745\ R\ (dR) \qquad (5)$$

dA and dR are the infinitesimal increments of the differential calculus. For illustrative purposes, dR can be thought of as a very small number, much less than 1 ft.

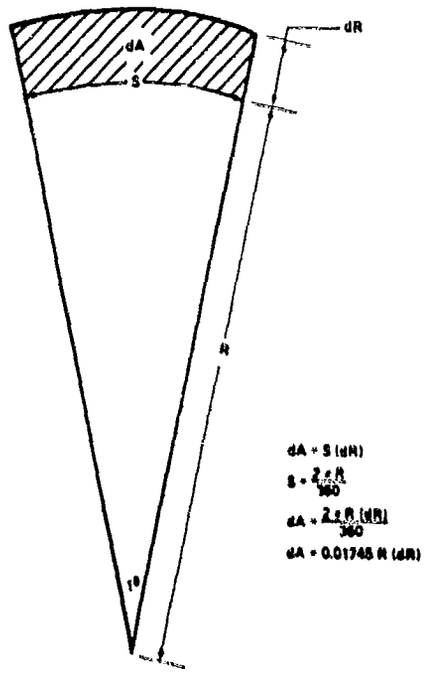



Figure 29. Incremental Area at Range R for a 1° Azimuthal Zone in the Ground Plane

DENSITY RELATION

Finally the density of fragments at range R is obtained by dividing the number of fragments between R and R + dR by the area between R and R + dR for a 1° azimuthal zone; that is, divide Equation (4a) by Equation (5).

$$\frac{dN}{dA} = \left[ 57.3 \left(\frac{-b}{3}\right)\left(\frac{M}{a}\right)^{1/3} R^{-\left(\frac{b}{3}+2\right)} N_{OA}N_{IA}e^{-\left(\frac{MR^{-b}}{a}\right)^{1/3}} \right. \tag{6}$$

where

dN/dA = fragment density (fragments/ft$^2$)

VALIDATION OF EMPIRICAL RELATION

The accuracy of Equation (6) can be evaluated by comparing the density predicted for the large-scale, multiple-pallet detonation test configurations to actual recovery data for these tests. For this purpose, a modified version of Equation (3) can be used more efficiently. The relation is

$$N_{R_1R_2} = N_{AZ}N_{IA} \quad N(R>R_1) - N(R>R_2) \tag{3a}$$

where

$N_{R_1R_2}$ = number of fragments in a particular recovery zone between ranges $R_1$ and $R_2$

$N_{AZ}$ = number of degrees of azimuth encompassed by the chosen recovery zone

$N_{IA}$ = number of interaction areas in stack wall adjacent to recovery zone

The values of the constants required are calculated from the natural communication arena test data (QD-155-SC12). The data from polar zone 90 to 105° and azimuthal zone 90 to 105° were used to calculate these values

$N_{OA}$ = 3062.4

M = 6086.4

a = 44491.4

b = -1.1369

The results of using these values and the multiple-pallet detonation configuration (i.e., number of interaction areas) are plotted in Figures 30

through 32. Also shown is the actual number of recovered fragments. The accuracy of the prediction is excellent. It is apparent that the empirical relation is a valid and conservative estimate of the far-field fragment density resulting from the detonation of 155-mm projectiles.

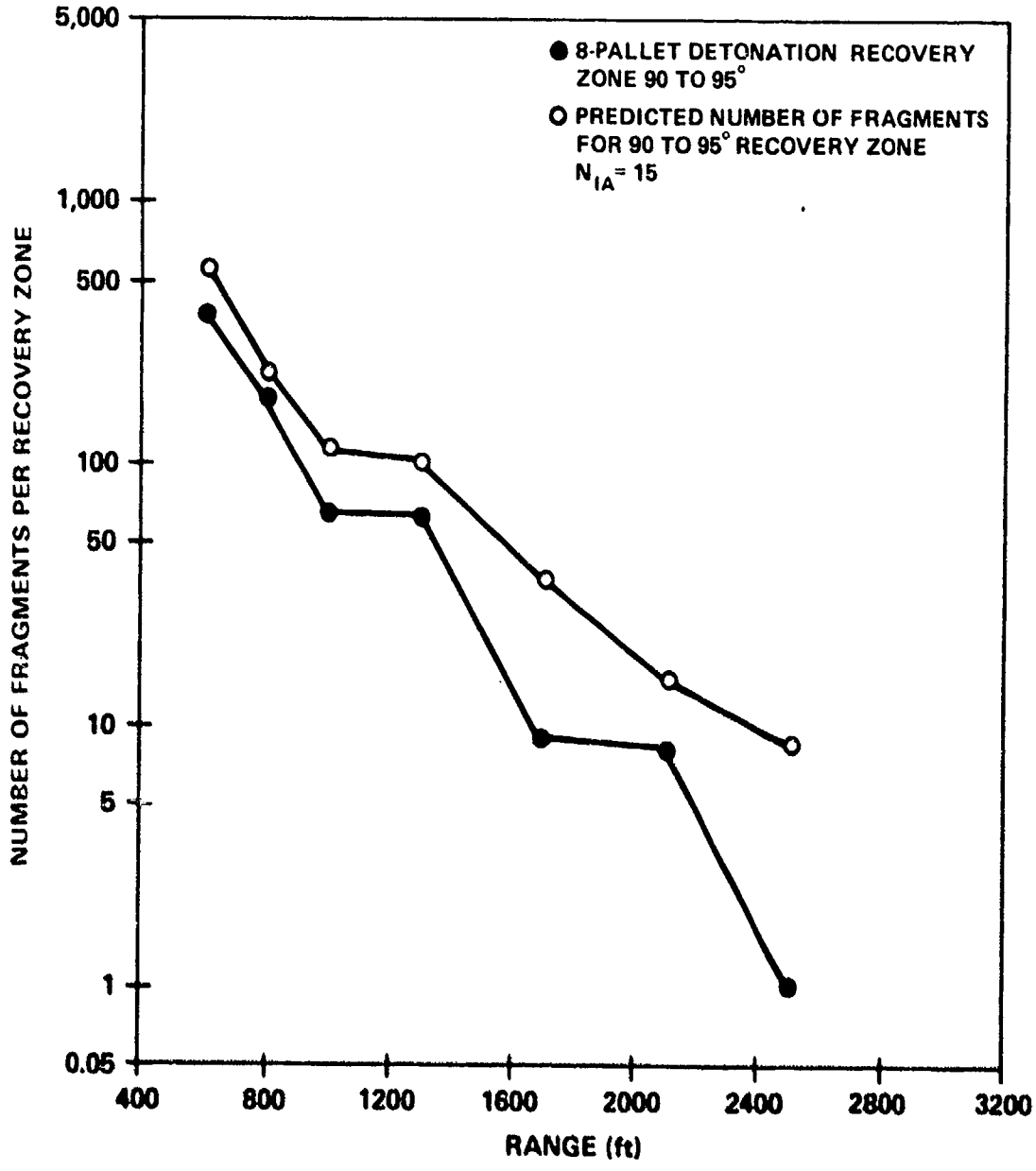



Figure 30. Predicted and Actual Number of Fragments for 8-Pallet Detonation

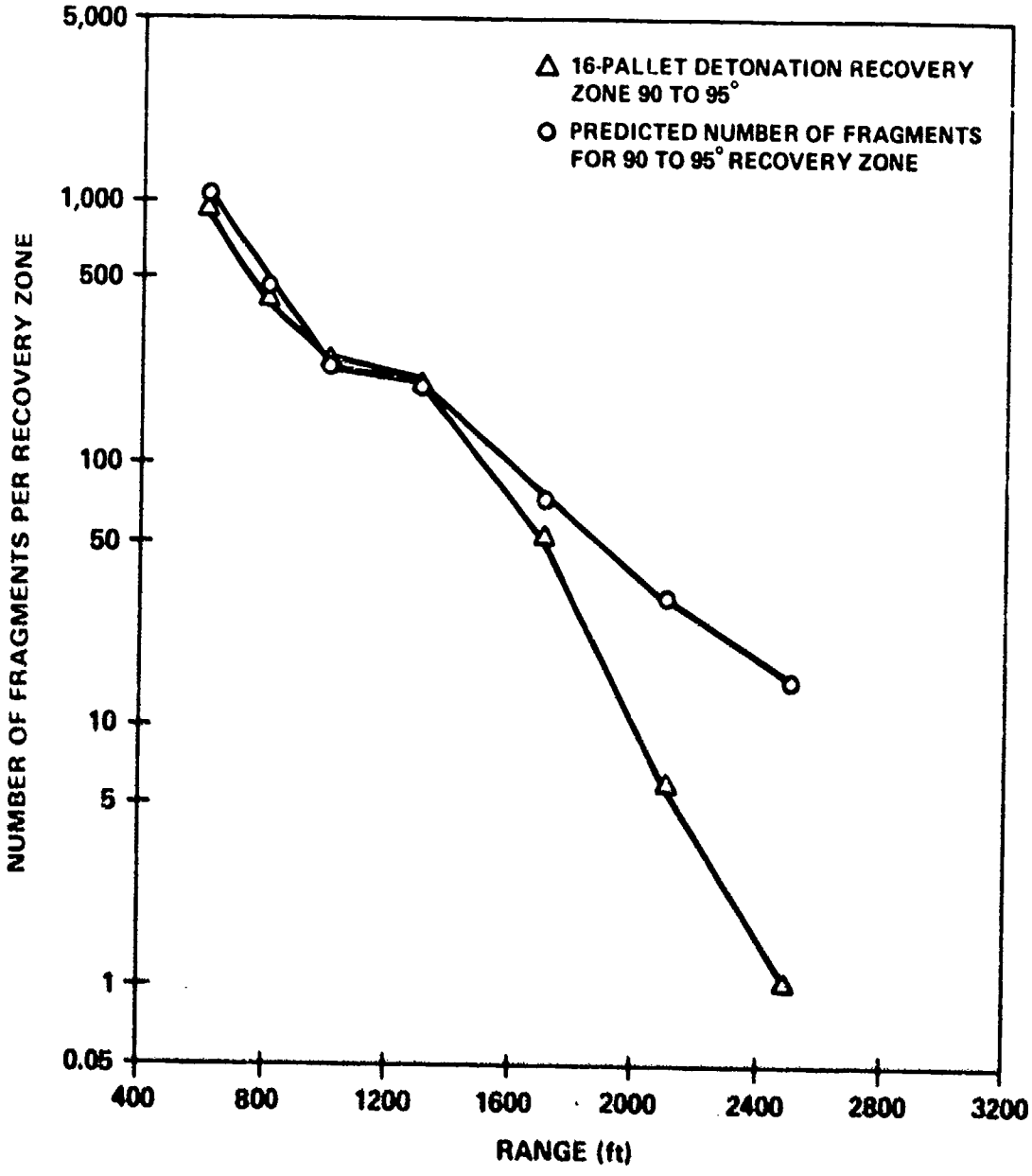



Figure 31. Predicted and Actual Number of Fragments for 16-Pallet Detonation

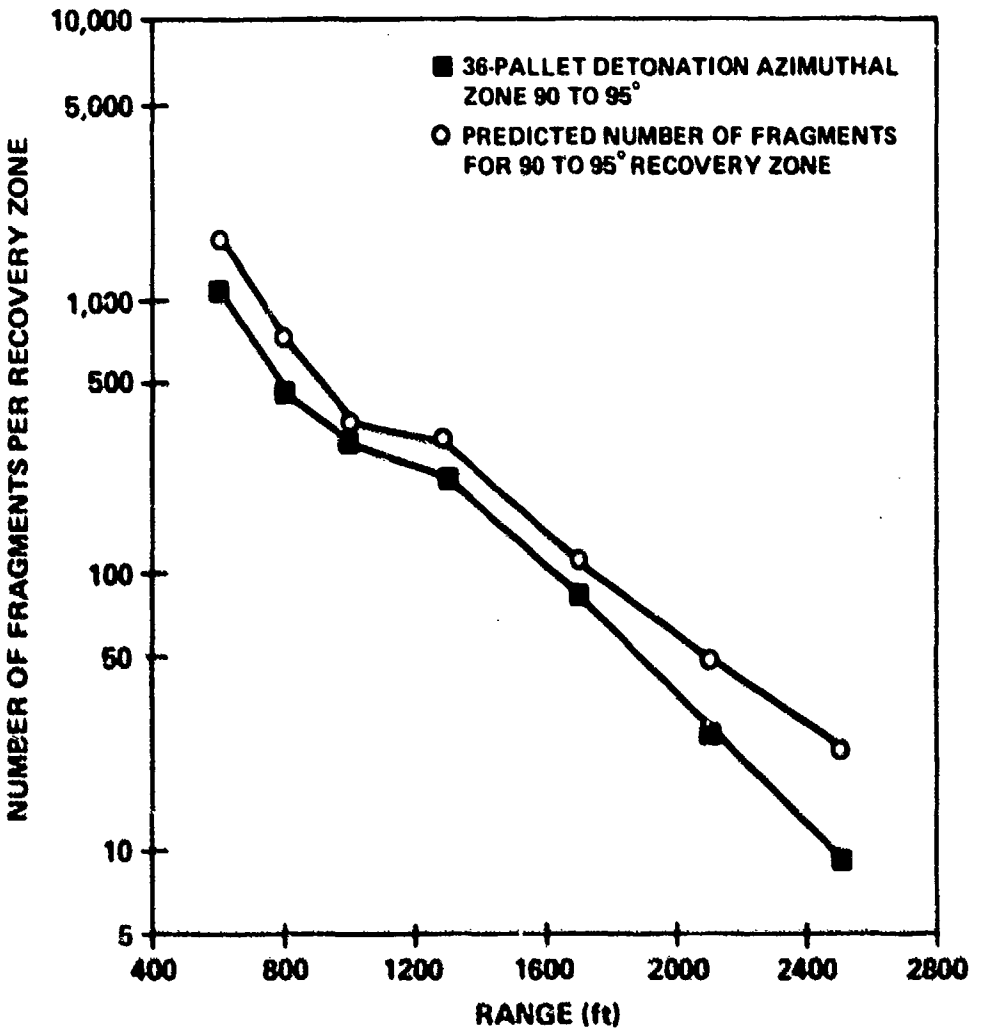



Figure 32. Predicted and Actual Number of Fragments for 36-Pallet Detonation

## IMPLICATIONS FOR QD REQUIREMENTS

QD requirements for fragments are based upon both fragment density (1/600 $ft^2$) and terminal KE (58 ft/lb). Equation (6) can be used to calculate the range at which a density of 1/600 $ft^2$ occurs. However, the calculation of the hazardous fragment density is somewhat more complex and will be discussed in detail. Fragment KE at impact is defined as

$$KE = \frac{WV_F^2}{2g} \tag{7}$$

where

KE = kinetic energy (ft/lb)

W = fragment weight (lb)

$V_F$ = impact velocity (ft/sec)

g = acceleration of gravity ($ft/sec^2$)

Two more relations are required. The first relation is obtained from a particle trajectory program. It can be shown that

$$V_F = c\gamma^d \tag{8}$$

$V_F$ = final (impact) velocity (ft/sec)

$\gamma$ = fragment average presented area to weight ratio ($in.^2/lb$)

c,d = constants developed from data fit, d is always negative

The second relation developed from the relation of fragment weight and gamma is

$$\gamma = fW^h \tag{9}$$

or

$$W = \left(\frac{\gamma}{f}\right)^{\frac{1}{h}}$$

where

W = fragment weight (grains)

$\gamma$ = fragment average presented area to weight ratio ($in.^2/lb$)

f,h = constants developed from least-squares fit to the data, h is always negative

Substituting Equations (8) and (9) into Equation (7) yields

$$KE = \frac{\left(\frac{\gamma}{f}\right)^{\frac{1}{h}} C^2 \gamma^{2d}}{4.508 \times 10^5} \qquad (7a)$$

Finally, Equation (2a) is substituted into Equation (7a), and the expression solved to yield

$$R_H = \left[ \frac{4.508 \times 10^5 (KE) f^{\frac{1}{h}}}{C^2 \left( a^{\frac{1}{h}} + 2d \right)} \right]^{\frac{1}{\frac{b}{h} + 2bd}} \qquad (2b)$$

where

$R_H$ = the range at and beyond which all fragments will possess a specified KE level (ft)

The equation can be used with parameters developed from the single-pallet arena test (QD-155-SC12) to determine the range at which all fragments will be hazardous (KE>58 ft/lb). The parameters used are

a = 79405

b = -1.1603

c = 375.0

d = -0.4712

f = 107.6

h = -0.3607

$V_o$ = 6500 ft/sec

$\alpha$ = 20°

$C_D$ = minimum from Figure 27

KE = 58 ft/lb

Using these values in Equation (2b) results in a value of 2770 ft for $R_H$. The accuracy of this equation can be evaluated by analyzing the fragment recovered from the 36-pallet detonation test (recovery zone 90 to 95°). Figure 33 presents the results of estimating the percentage of hazardous fragments at each range using Equations (7), (8), and (9). The plot shows that the percent-

age of hazardous fragments approaches 90% at 2500 ft. This is a good indication that Equation (2b) is correct. However, Equation (2b) does not provide the percentage of hazardous fragments as a function of range. What is required is a relation that calculates the percentage of hazardous fragments as a function of range.

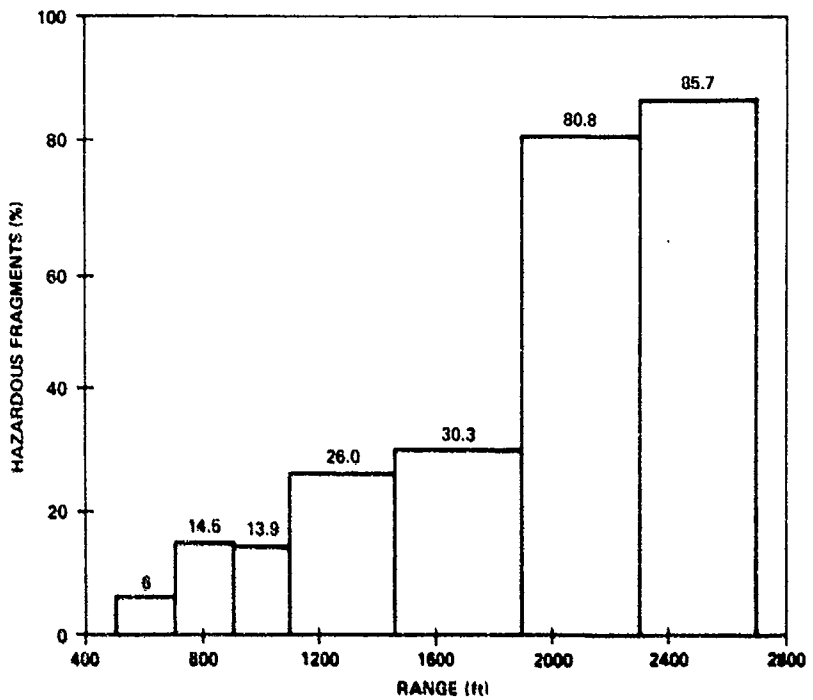



Figure 33. Estimated Percentage of Hazardous Fragments as a Function Range

The excellent agreement between the predicted and actual number of fragments per recovery zone in the multiple-pallet detonation tests (Figures 30 through 32) strongly implies that the majority of the recovered fragments are ejected from the stack at the optimum ejection angle (5 to 45°). Therefore, the fragments will impact at the velocity calculated by Equation (8) and possess the KE calculated by Equation (7). Consequently, the data presented in Figure 33 for the 36-pallet detonation test should be an accurate representation of the percentage of hazardous fragments as a function of range. A good fit to these data is provided by

$$P_H = N_i e^{K R_i} \qquad (10)$$

where

$P_H$ = fraction of fragments that are hazardous

$R_i$ = range of interest (ft)

$N_i$, K = constants derived from a least-squares fit to the data in Figure 33

Values calculated for the 36-pallet detonation test are

$$N_i = 0.099$$

$$K = 8.53 \times 10^{-4}$$

Applying Equation (10) to the density relation, Equation (6),

$$\left(\frac{dN}{dA}\right)_{HAZ} = 57.3 \left(\frac{-b}{3}\right)\left(\frac{M}{a}\right)^{1/3} R_i^{-\left(\frac{b}{3}+2\right)} N_{OA} N_{IA} F_H e^{-\left(\frac{MR_i}{a}\right)^{-b}}^{1/3} \quad (6a)$$

where

$\left(\frac{dN}{dA}\right)_{HAZ}$ = hazardous fragment density (fragments/ft$^2$)

This equation can be solved for the range at which a density of one hazardous fragment/600 ft$^2$ occurs. Figure 34 presents a plot of this range as a function of stack size and configuration ($N_{IA}$). Also plotted is the currently used blast criteria (40 $W^{1/3}$) for each stack. The plot shows that the existing 40 $W^{1/3}$ criteria significantly underestimates the fragment hazard from the detonation, in the open, of a stack of 155-mm projectiles.

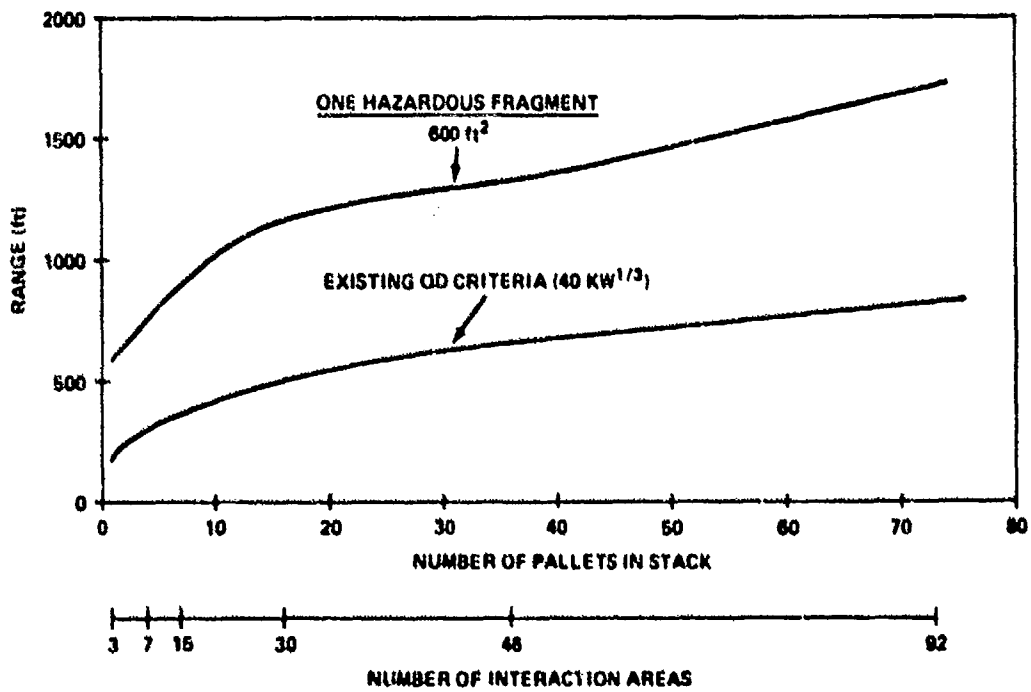



Figure 34. Fragment Hazard Range

## LIMITATIONS OF METHODOLOGY

There are a number of limiting assumptions for the previously discussed methodology that need to be addressed in greater detail. These assumptions and their effects upon the validity of the methodology are discussed in this section.

### DENSITY RELATION

The development of the density relation (Equation (6a)) is based upon the assumption that the fragments are ejected from the stack at optimum angles (5 to 45°). However, the multiple-pallet detonation tests clearly show that the fragments recovered from the far-field are similar in weight-number distribution to fragments from polar zone 90 to 105° of a single pallet. These fragments should be ejected at a negative angle (toward the ground) and impact well before 500 ft. Obviously, the detonation of a multiple-pallet stack is not absolutely identical to the detonation of a single pallet. The mechanism by which these fragments are ejected from a multiple-pallet stack needs further investigation.

### HAZARDOUS FRAGMENT

The calculation of the KE of fragments recovered from the multiple-pallet detonation tests is also based upon assuming optimum ejection angles, a single value for initial velocity and the average $C_D$ curve. These assumptions ignore fragments that do not meet these criteria. A potentially significant number of fragments could be ejected at lower angles (1 to 5°) and somewhat lower velocity (up to 50% less). These fragments can travel to distances that would overlap the far-field fragments by approximately 80% based upon particle trajectory calculations. The low-angle fragments will also possess a much higher impact velocity than the optimum angle fragments. These fragments will impact with greater KE than similar fragments from optimum angles. The existing test data are insufficient to determine the relationship between the proportion of low and optimum ejection angle fragments. The potential increase in the percentage of hazardous fragments at each range cannot be evaluated at this time.

### SENSITIVITY OF PARAMETERS

The entire methodology is based upon variables that are calculated from analytic fits to test data. No attempt has been made to determine the sensitivity of the density calculation to variations in these variables.

## SIZE OF STACK

The methodology assumes there is no limit to the number of interaction areas in the stack. However, for very long stacks a point will be reached where the first and last fragment concentrations will no longer overlap. This limit has not been identified.

## FRAGMENT HAZARD CRITERIA

A modification of the existing fragment criteria (KE>58 ft/lb, 1/600 $ft^2$) would significantly affect the hazardous range calculation. For example, if it is assumed that

$$P_H = 1 - e^{-\rho A}$$

where

$P_H$ = probability of one or more hits on a target (Poisson Distribution)

$\rho$ = fragment density (fragments/$ft^2$)

A = presented area of the target ($ft^2$)

Structures would normally have presented areas greater than 100 $ft^2$. An average size man has a presented area of 5.6 $ft^2$ and a very large man 7 $ft^2$. The probability of hit by one or more fragments for various presented areas is shown in Table 6.

Table 6. Probability of Hit for Target Area ($ft^2$)

| Density (fragments/ $ft^2$) | Man ($ft^2$) | | Structure ($ft^2$) | | | |
|---|---|---|---|---|---|---|
| | 5.6 | 7 | 100 | 600 | 2000 | 5000 |
| 1/300 | 0.018 | 0.023 | 0.283 | 0.865 | 0.999 | 1.000 |
| 1/600 | 0.009 | 0.012 | 0.154 | 0.632 | 0.964 | 1.000 |
| 1/1200 | 0.005 | 0.006 | 0.080 | 0.393 | 0.811 | 0.984 |
| 1/2400 | 0.002 | 0.003 | 0.041 | 0.221 | 0.565 | 0.875 |

Changing the allowed fragment density can affect the probability of hitting a target and, therefore, will affect the hazardous fragment density calculation (Equation (6a)). Furthermore, the 58-ft/lb criteria is based on a personnel casualty criteria used prior to the advent of the more definitive wound ballistic equations developed in the 1950's. The rule defines the KE for severe wounding. A 1-in.-diameter steel sphere (0.15 lb) traveling at 108 mi per hr has a KE of about 58 ft/lb. Reducing this criteria would also affect the hazardous fragment density calculation.

## CONCLUSIONS AND RECOMMENDATIONS

The present study provides a methodology for using small-scale single pallet arena data to determine the fragment hazards produced by the detonation of large stacks (up to 36 pallets of 155-mm projectiles in open storage). However, the methodology has limitations and cannot presently be applied to other mass-detonating munitions. The following is a summary of conclusions and recommendations necessary to improve the emerging methodology.

1. It is recommended that a detonation test be conducted with a stack representative of that found in a "typical" magazine. The far-field fragments from this detonation will be collected and analyzed to determine the validity of the methodology. A follow-on detonation of an identical stack inside a simulated magazine should be conducted to determine the effect of magazine structures on far-field fragment density.

2. The ejection angle of fragments from a multiple-pallet detonation needs to be determined. Arena tests of multiple-pallet detonations should be conducted to evaluate the fragment ejection angle. These data are necessary to improve the evaluation of fragment KE criteria.

3. The sensitivity of the density equation to variations in input variables should be evaluated. The methodology should be modified as necessary to minimize adverse effects.

4. An entirely different type of mass-detonating ammunition should be tested to evaluate the applicability of the methodology. Arena tests and large-scale, multiple-pallet detonation tests should be conducted.

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5. Joint Munitions Effectiveness Manual, *Test Procedures for High Explosives Munitions,* NAVAIR 00-130-ASR-2-1, (Washington, D.C., 8 December 1970).

6. C. N. Kingery, *Air Blast Parameters Versus Distance for Hemispherical TNT Surface Bursts,* BRL 1344 (Aberdeen Proving Ground, Md., September 1966).

7. Nicholas J. Moga and Keith M. Kisielewski, *Vertical Wind Tunnel Tests to Determine Subsonic Drag Characteristics of Unscored Warhead Fragments,* NSWC TR 79-112 (Dahlgren, Va., May 1979).

8. D. J. Dunn, Jr. and W. R. Porter, *Air Drag Measurements of Fragments,* BRL (Aberdeen Proving Ground, Md., August 1955).

# APPENDIX A

# FRAGMENTATION TEST METHODS

## INTRODUCTION

The fragmentation tests conducted throughout the Fragment Hazard Investigation Program were designed to gather fragment mass, velocity, and spatial distribution data. The basic test procedures reflect the ones agreed upon by the services.* The purpose of this discussion is to provide a general description of the techniques, definitions, and methods utilized throughout the testing portions of the program.**

## GEOMETRIC CONSIDERATIONS

In conducting a fragmentation test, certain basic principles must be considered. One of these is munition geometry. Most frequently, munitions have an axis of symmetry (e.g., the longitudinal axis of a gun-fired projectile). Defining the longitudinal axis as the polar axis, we can see from Figure A-1 that fragmentation characteristics would be functions of the polar angle, $\theta$, but for a given polar angle, should be independent of the azimuth angle, $\alpha$.

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*Joint Munitions Effectiveness Manual, *Test Procedures for High Explosives Munitions*, NAVAIR 00-130-ASR-2-1 (Washington, D.C., 8 December 1970).

**D. J. Ammerman and M. R. Jamison, *Fragmentation Test Facilities Methods and Data Processing Used at NSWC*, NSWC MP 81-16 (Dahlgren, Virginia, June 1981).

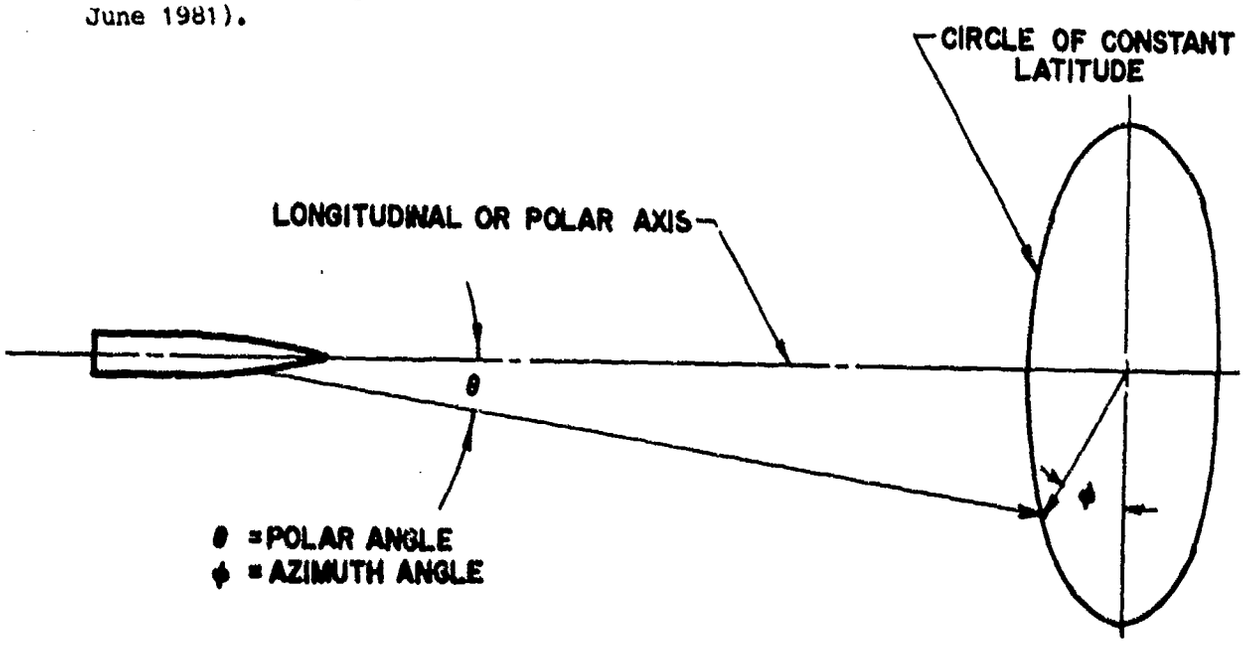


Figure A-1. Polar and Azimuth Angles

With the independence of $\alpha$, it is unnecessary to sample all fragments when characterizing a single item. A portion of the fragments can be sampled, and the results can be extended to predict the characteristics of the entire munition. However, when characterizing a multiple-munition detonation, as in a pallet of 155-mm projectiles, it is important that as much emphasis as necessary be placed on sampling fragments from the azimuth angles, as well as, from the polar angles.

The fragmentation characteristics are generally sampled in various $\theta$ intervals between $\theta = 0°$ at the munition nose and $\theta = 180°$ at the munition base. At NSWC, $\theta$ is generally divided into 5° increments called polar zones, although for smaller munitions, it may be divided into 10 or 15° intervals. Figure A-2 illustrates the surface area of one such zone, and Figure A-3 shows how a portion of that zone is sampled. The area of the portion of a polar zone covered by the recovery media, as projected on a sphere equal to the radius of the recovery media, is divided into the total surface area of the polar zone. This ratio yields a zone factor or zone multiplier (usually shortened to multiplier). Theoretically, if one takes the number-mass product of recovered metal fragments from each polar zone times its multiplier and sums this over all polar zones, the resultant mass should equal the original mass of metal in the tested munition.

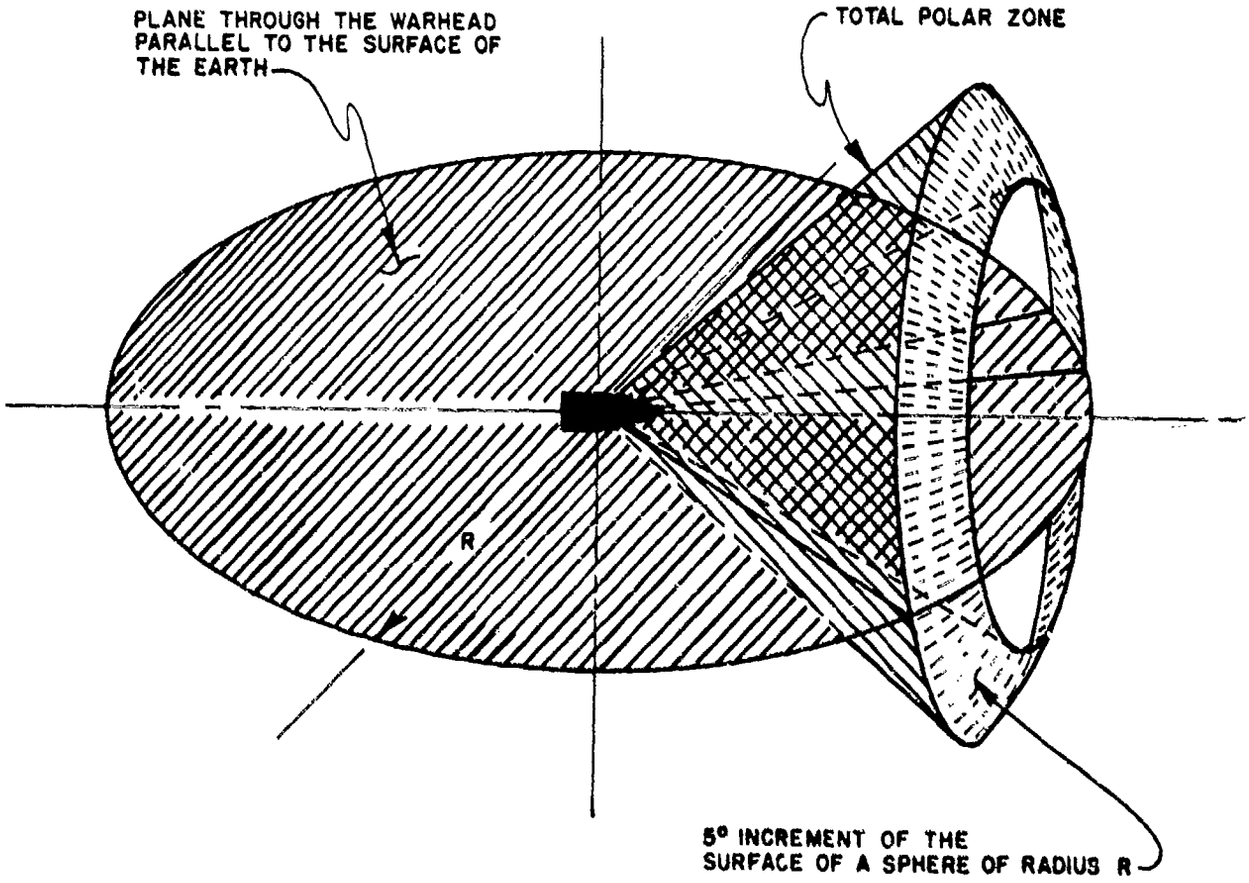


Figure A-2. Surface Area of a Polar Zone

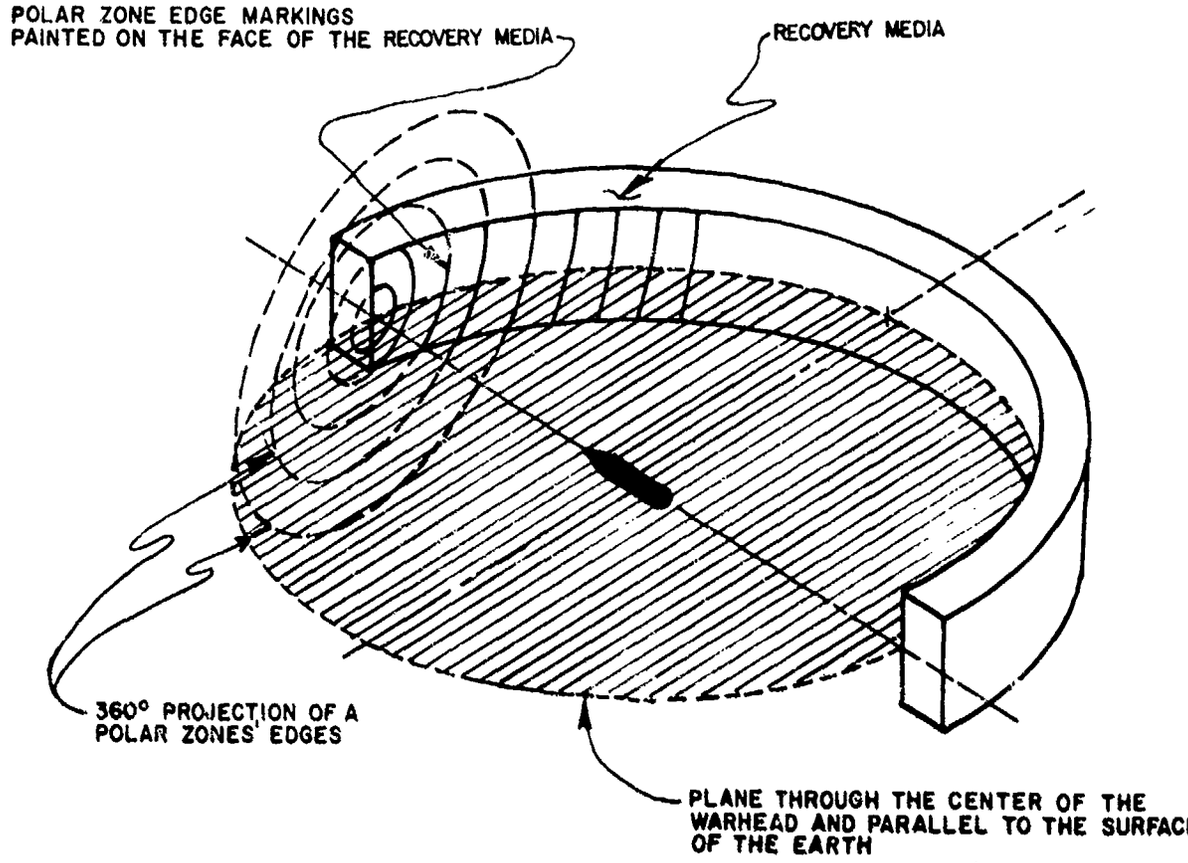


Figure A-3. Sampling of a Polar Zone

In some cases, munitions possess only partial symmetry about the longitudinal axis. Examples are bombs with lifting lugs or voids caused by explosive shrinkage following casting, or fins, bomblets with aerodynamic flutes, etc. When this occurs, it is necessary to sample fragments from each portion of the casing in which azimuthal symmetry does not exist as well as from symmetrical portions. When doing this, one must carefully sort out fragments resulting from asymmetry prior to applying multipliers.

Fragments from most munitions travel at supersonic speed over the distances at which their velocities are measured. Little error is introduced by assuming they travel in a straight line during the supersonic portion of their trajectory. Consequently, the number of fragments per unit area can be assumed to decrease inversely with the square of the distance from the munition. By analogy with radiation geometry, a target area can be expressed by the nondimensional solid angle that it subtends; thus, the density of fragments in this area can be identified as the number of fragments per steradian.

FRAGMENTATION ARENA

Figures A-4 and A-5 illustrate the manner of constructing a typical fragmentation arena. The recovery media is made up of cane fiberboard panels. Each panel is 4 by 8 ft by 1/2-in. thick, and 96 panels are bundled together to make a 4-ft-thick bundle commonly called a celotex pack. These packs are arrayed over all polar angles at a prescribed radius for the test item. As a rule of thumb, this radius is approximately 10 $W^{1/3}$ ft where W is the explosive weight (lb) of the test item. The results of this figure are generally rounded off to the next higher 5- or 10-ft interval. The bundles are set tightly against each other. In the beam spray and at the polar extremities, extra backup recovery packs are placed so that no energetic fragments pass completely through. In addition, an extra recovery pack is usually placed at both $\theta = 0$ and 180° to ensure that all fragments from the polar zones at the nose and base of the test item are caught.

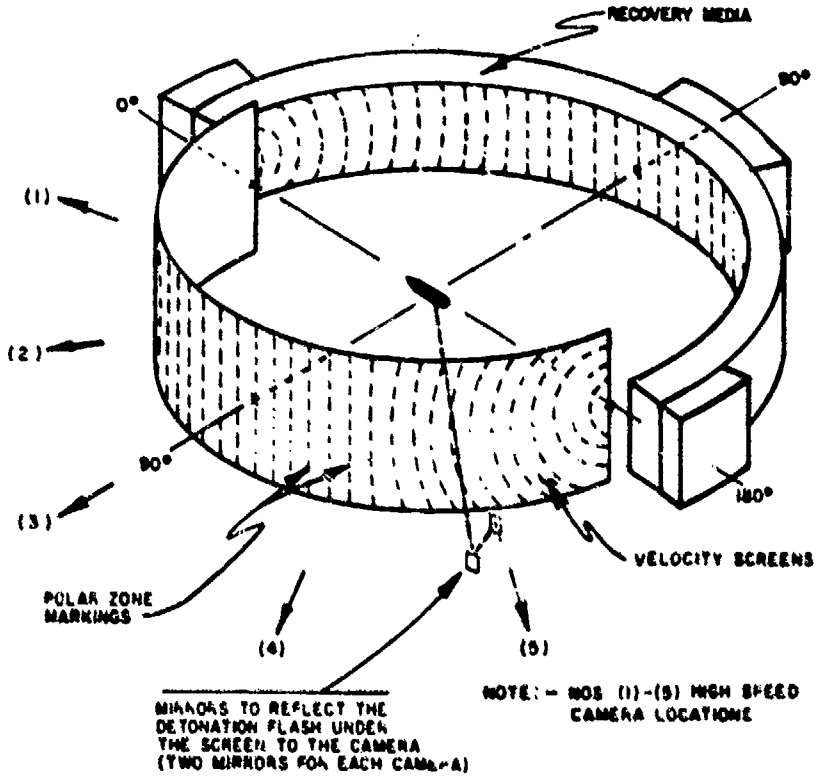


Figure A-4. Sketch of Typical Fragmentation Arena

Velocity data in these arenas are usually acquired by using high-speed framing cameras and witness panels. The usual material for witness panels is 22-gauge-mild-steel plate that is sold in 4- by 12-ft sheets. These sheets are positioned on the opposite side of the arena from the recovery packs and cover all polar angles from $\theta = 0$ to 180°. They are generally positioned at a radius above 75% as large as the recovery pack radius. High-speed framing cameras are positioned outside the witness panels, and they photograph the flash of each

fragment as it impacts and perforates the witness panel. A mirror arrangement is used so that the test item is in the camera field of view prior to detonation. The initial flash of the detonating test item provides a zero point, and the 1-kHz timing marks on the film edge provide a time reference on the film. For a witness panel radii of 40 ft and less, the cameras should have a minimum frame rate of 10,000 frames per second. At larger radii, frame rates on the order of 5,000 to 6,000 frames per second are sufficient. Sufficient cameras should be used that an individual camera is photographing only 15 to 20 ft of witness plate, and the curvature of the plate will not be enough to cause parts of the plate to be out of focus.

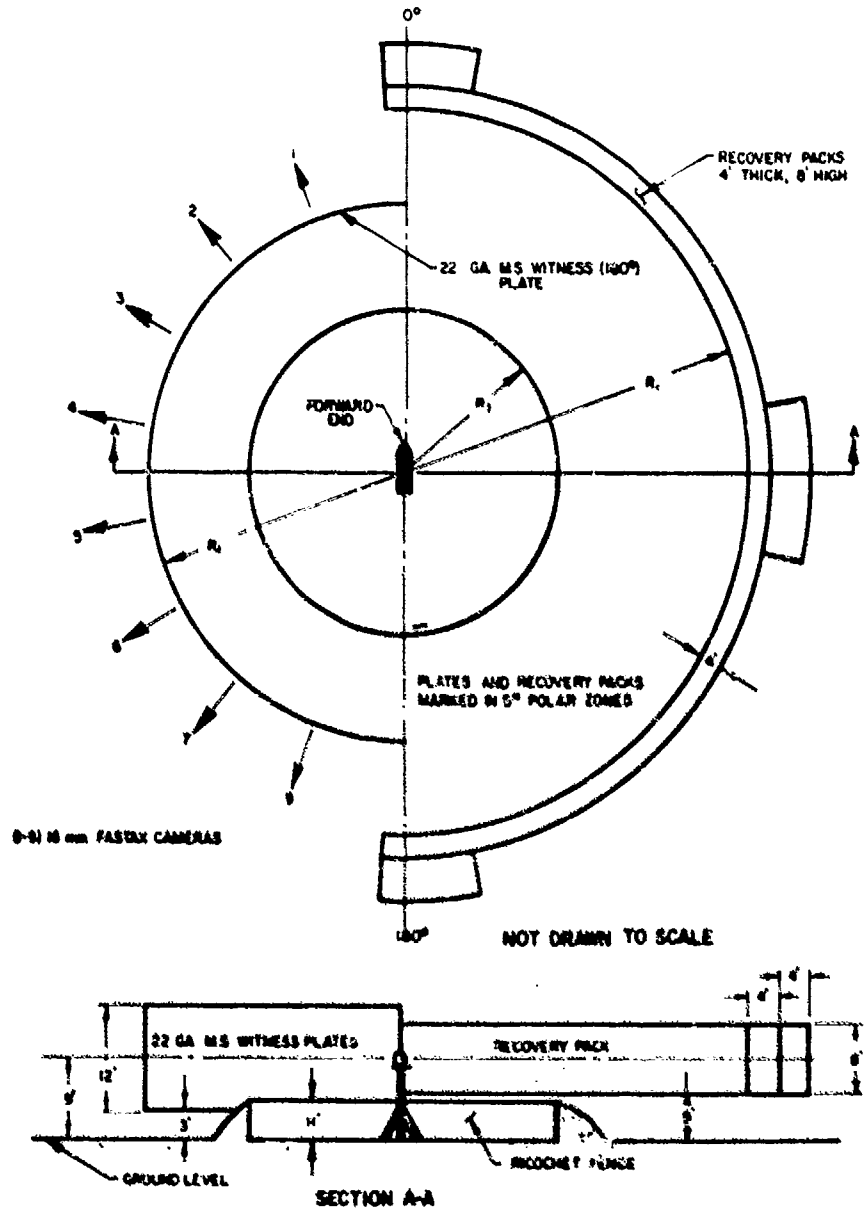


Figure A-5. Plan and Profile of Typical Fragmentation Arena

The test items should be positioned horizontally, with the forward end oriented toward $\theta = 0°$ and the base end at $\theta = 180°$, on a custom-built wooden stand to hold it. This stand is placed on a thick steel base plate at the arena center. This base plate serves (1) to prevent localized cratering at the arena center as a result of the detonation and (2) as a reference point from which all elevations in the arena are measured. The recovery media should be soaked with water just prior to initiation and again after the test, and a fire watch should be maintained for several hours after the test.

Inside the witness panels and recovery packs, a ricochet fence is constructed. This can be earthen or steel backed up by earth. Its function is to prevent fragments from ricocheting off the ground, inside the arena, into the witness panels or recovery packs. In determining the height of a ricochet fence, it is assumed that the path angle of a fragment bouncing from the ground is equal to the angle of its path in striking the ground. An analogy can be made here with the law of geometrical optics--the angle of incidence a light beam makes with a reflecting surface is equal to the angle of reflection.

Prior to constructing the arena, the face sheets of the recovery packs and the outside faces of the witness panels should be marked with the polar zone markings. The panels are laid out on the ground, and arcs are struck on them using the results of a computer program that calculates the radius of curvature for each polar zone arc and determines the location of the center of curvature with respect to the point $\theta = 0$ or 180°. The computer program also calculates the polar zone multipliers to be used with that size arena. In order to obtain all these quantities, the number of polar zones in the arena, the interval between polar zone boundaries, the arena radius, and the height of the recovery packs must be provided as program input.

A sample of from two to five (usually three) test items is fired in a test arena. The same recovery packs are used for all detonations; however, new witness panels are erected for each test item. There is some hazard in this procedure, if the second or a subsequent test item does not detonate properly, the entire set must be repeated. There is little probability of this, and the economics of fragment recovery after a single round make such a procedure prohibitive.

Immediately following each test, the following data should be recorded.

1. Date
2. Time of firing
3. Ambient temperature, pressure, and relative humidity
4. Number of perforations in each zone of each witness panel

Following the detonation of the last test item, fragment recovery from the recovery packs commences. Fragment recovery is a lengthy procedure that requires a crew of men several days. Each pack is inspected panel by panel for fragments. In some cases, it is evident that a fragment has passed completely

through a panel; in others, it is not evident. Hand-held magnets and electronic metal locators are used to aid in locating fragments. The type of electronic metal locator used is a surgical metal detector. It is extremely sensitive to ferrous metal and reasonably sensitive to nonferrous metals. When fragments are found, they are catalogued according to polar and azimuth zones. The face sheet of the pack can be used as a template for this purpose. The apparent path of a fragment in a recovery pack should be followed so that the fragment can be catalogued by the polar zone of entry into the recovery pack. Recovered fragments are then cleaned and weighed.

## DATA REDUCTION

The data reduction is divided into two main parts. The first has to do with fragment-mass distributions; the other is the velocity distribution.

### FRAGMENT-MASS DISTRIBUTION

Most work concerned with fragment mass distribution is done at the fragment weighing house. As fragments from a given test are brought to the weighing house, they are catalogued with an identifying number that stays with that particular test from then on.

The first process, following the assignment of an identifying number, is cleaning the fragments. During testing, fragments impact the recovery media with such force that minute quantities of the recovery media adhere to the fragments and become embedded in the irregular fragment surface. Individually, this could affect the weight distribution by causing a fragment to be listed in a higher weight group than it belongs in. Cumulatively, the total mass recovered would be affected; thus, distorting the total percentage recovery. In most cases, it is relatively easy to clean the recovery media from fragments having a low-impact velocity (less than 1500 ft/sec). Cleaning fragments with higher impact velocities is much more difficult. The cane fiberboard of the recovery media adheres to the fragment almost as though it were glued on. A sandblaster type device with micron-sized aluminum-oxide granules is used for the cleaning process.

Following cleaning, the fragments are sorted into weight groups. The test engineer must preselect the desired weight groups. As a part of the sorting and cleaning process, the fragments are inspected to ensure that they are valid fragments. Ricochet fragments are removed. Metal filings, rusted paint flakes, and residue from welding repairs in the arena, etc., are also removed at this time. This requires a keen eye, in some cases, to decide whether or not a fragment is valid. After all fragments (or all fragments from a particular spatial zone) are weighed and sorted, the final data processing is handled by an assortment of computer programs. Computer programs are available to perform Mott Plot or ballistic density comparisons, to calculate range and trajectory data, to provide statistical fits to fragment area-to-weight

relationships, and, finally, to provide a list of the fragment weight-number distributions according to polar and azimuthal zones.

## MEAN PRESENTED AREA DETERMINATION

The mean presented ($\bar{A}$) area is used in determining retardation of a fragment during flight due to air resistance. Thus, it is important to the test activity so that initial velocity may be determined as accurately as possible from the average velocity measurements made during a test. It is important to the user of fragmentation data in that the velocity decay of a fragment plays a large part in determining the lethal area of a round of ammunition.

Mean presented area is determined by use of an icosahedron gauge. An icosahedron is the regular solid with the largest number of faces of all regular solids. For this reason, its shape was chosen as the basis for selecting angular positions for measuring presented area of fragments. *Ammunition and Explosives Ashore** explains the theory behind the gauge and the selection of the 16 angular positions used. The gauge itself consists of a point light source collimating lens, gimbal system for supporting fragments, condensing lens, light detector, and indicating device. Fragments are mounted in the gimbal system so that they are in the path of the collimated light beam. The gimbal system is stepped through each of the 16 positions, and the presented area is recorded. The average of these 16 areas is taken as the mean presented area of that particular fragment.

In practice, a minimum of 100 fragments from the particular area under investigation are chosen for gauge measurements. A plot of mean presented area versus mass (M) on log-log paper is approximately a straight line, with the slope equal to the constant c + 1 in the equation $A = bM^{c+1}$ where the vertical axis intercept is equal to c + 1. To get the ratio $A/M = bM^{c}$, the data are processed through a computer program. The program takes the values of mass and mean presented area for each fragment as input data and goes through a least-squares fitting procedure to determine the value of the equation.

## FRAGMENT-VELOCITY DISTRIBUTION

Fragment-velocity distribution is determined by measuring the time of flight of fragments into the witness panels of Figure A-4. As shown in Figure A-6, the distance over which the measurement is taken is divided by the measured time-of-flight to obtain an average velocity for a particular strike. The first few velocities in a given polar zone are summed and divided by the number of readings made. This mean value is used as the average velocity for a polar zone. It is also used in calculating an initial velocity to be used for fragments from that polar zone.

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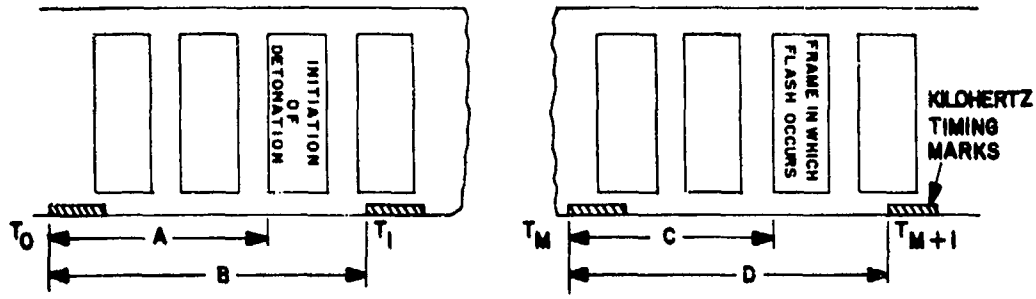
* Naval Sea Systems Command, Storage Data, *Ammunition and Explosives Ashore*, OP 5 Volume II Third Revision (Washington, D.C., 15 September 1970).




$$T_F = .001 \left( T_M + \frac{C}{D} - \frac{A}{B} \right)$$

$T_F$ = TIME OF FLIGHT IN SECONDS

$T_M$ = NUMBER OF TIMING MARKS FROM ORIGIN

A = LINEAR DISTANCE FROM $T_O$ TO INITIATION

B,D = LINEAR DISTANCE BETWEEN TIMING MARKS BRACKETING FRAMES OF INTEREST.

C = LINEAR DISTANCE FROM $T_M$ TO FRAME OF FLASH

Figure A-6. Diagram and Equation for Obtaining Time-of-Flight from Film

# APPENDIX B

## INDIVIDUAL STATIC ARENA TEST SHEETS

FRAGMENT HAZARD INVESTIGATION

Test Number: QD-155-S2

Item Tested: M107 155-mm projectile, 15-lb TNT

Configuration: Two projectiles vertically positioned, side-by-side, with the projectile centerlines parallel and 7 in. apart

Number of Firings/Date: 2/12 July 1977

Location: NSWC/Experimental Explosive Area

Zone Information: Fragment hole count: 90 to 105° Polar
360° Azimuth

Meteorology: 27 July 1977
Barometric Pressure: 31.05 in Hg
Temperature: 98°F

Instrumentation: Fragment velocity--five high-speed motion picture cameras, black and white film

Fragment Velocities
Firing No. 1
Test QD-155-S2

| Azimuthal Zone (°) | Velocity* (ft/sec) per Polar Zone (°) | | |
|---|---|---|---|
| | 90-95 | 95-100 | 100-105 |
| 0 - 10 | 3880.0 | 4006.7 | 4000.3 |
| 10 - 20 | 5102.0 | 5525.0 | 4166.7 |
| 20 - 30 | 5747.9 | 6024.1 | 5000.0 |
| 30 - 40 | 6330.1 | 6135.2 | 6578.9 |
| 40 - 50 | 4902.0 | 4902.0 | 5235.7 |
| 50 - 60 | 4065.0 | 4098.4 | 4545.5 |
| 60 - 70 | 3893.9 | 4004.6 | 3429.8 |
| 70 - 80 | 3973.9 | 4052.5 | 3464.6 |
| 80 - 90 | 4016.6 | 4032.6 | 3290.9 |
| 90 - 100 | 4085.8 | 4445.2 | 3472.3 |
| 100 - 110 | 4476.5 | 4077.6 | 3149.5 |
| 110 - 120 | 3970.6 | 3758.6 | 3498.3 |
| 120 - 130 | 4375.9 | 3866.9 | 3314.9 |
| 130 - 140 | 5082.6 | 4854.8 | 5227.0 |
| 140 - 150 | 6253.9 | 5128.3 | 5239.2 |
| 150 - 160 | 6379.6 | 6369.7 | 6666.7 |
| 160 - 170 | 6187.9 | 6098.5 | 6371.8 |
| 170 - 180 | 6172.8 | 4504.9 | 5618.0 |
| 180 - 190 | 3703.1 | 5495.2 | 4587.5 |
| 190 - 200 | 3459.9 | 3531.1 | 3367.8 |
| 200 - 210 | 3773.6 | 3787.9 | 3759.4 |
| 210 - 220 | 3922.1 | 3846.2 | 3731.3 |
| 220 - 230 | 3787.9 | 3676.5 | 3787.9 |
| 230 - 240 | 4032.3 | 3787.9 | 3333.3 |
| 240 - 250 | 3984.1 | 3379.0 | 3205.1 |
| 250 - 260 | 3807.8 | 4234 5 | 3538.2 |
| 260 - 270 | 4098.4 | 3918.9 | 3432.8 |
| 270 - 280 | 4143.2 | 4199.9 | 3436.3 |
| 280 - 290 | 3809.7 | 3700.9 | 3529.1 |
| 290 - 300 | 4000.0 | 4037.0 | 3035.7 |
| 300 - 310 | 3777.9 | 3648.7 | 3157.2 |
| 310 - 320 | 4207.4 | 3623.2 | 4000.3 |
| 320 - 330 | 4228.6 | 4226.5 | 3455.8 |
| 330 - 340 | 4009.2 | 4016.9 | 3504.0 |
| 340 - 350 | 3885.3 | 3871.0 | 3638.5 |
| 350 - 360 | 4065.0 | 3916.4 | 4033.3 |

* Velocities recorded photographically at 25-ft standoff

Fragment Velocities
Firing No. 2
Test QD-155-S2

| Azimuthal Zone (°) | Velocity* (ft/sec) per Polar Zone (°) | | |
|---|---|---|---|
| | 90-95 | 95-100 | 100-105 |
| 0 - 10 | 4141.3 | 4854.8 | 4525.0 |
| 10 - 20 | 6172.8 | 6097.6 | 6135.2 |
| 20 - 30 | 6329.1 | 6596.3 | 6313.1 |
| 30 - 40 | 6476.7 | 6172.8 | 5434.8 |
| 40 - 50 | 5465.9 | 4739.4 | 5208.3 |
| 50 - 60 | 3968.3 | 3952.6 | 4166.7 |
| 60 - 70 | 3906.3 | 3906.3 | 3676.5 |
| 70 - 80 | 3993.1 | 4032.3 | 3571.4 |
| 80 - 90 | 3936.7 | 3230.7 | 3271.5 |
| 90 - 100 | 3906.3 | 3537.9 | 3378.4 |
| 100 - 110 | 4009.9 | 3635.6 | 3787.9 |
| 110 - 120 | 3769.8 | 3667.4 | 3937.0 |
| 120 - 130 | 4166.7 | 3297.2 | 4065.0 |
| 130 - 140 | 4739.4 | 5000.0 | 5000.0 |
| 140 - 150 | 5133.6 | 6297.4 | 6329.1 |
| 150 - 160 | 6854.5 | 6580.1 | 6666.7 |
| 160 - 170 | 6411.3 | 6251.0 | 6493.5 |
| 170 - 180 | 5076.3 | 4951.0 | 5025.3 |
| 180 - 190 | 4062.5 | 3816.8 | 3921.6 |
| 190 - 200 | 4166.7 | 3623.2 | 3312.5 |
| 200 - 210 | 4262.4 | 3268.0 | 3862.9 |
| 210 - 220 | 4016.6 | 3676.5 | 3703.7 |
| 220 - 230 | 3906.3 | 3906.3 | 3649.6 |
| 240 - 250 | 4000.3 | 3676.5 | 3676.5 |
| 250 - 260 | 3968.3 | 3846.2 | 3759.4 |
| 260 - 270 | 3876.2 | 3424.7 | 3868.0 |
| 270 - 280 | 3787.9 | 3571.4 | 3846.2 |
| 280 - 290 | 3968.3 | 3787.9 | 3521.1 |
| 290 - 300 | 3906.3 | 3649.6 | 3676.5 |
| 300 - 310 | 3921.6 | 3937.0 | 3623.2 |
| 310 - 320 | 3846.2 | 3906.3 | 4065.0 |
| 320 - 330 | 4166.7 | 4166.7 | 4245.4 |
| 330 - 340 | 4069.9 | 4167.7 | 3971.6 |
| 340 - 350 | 4066.7 | 4169.3 | 3699.0 |
| 350 - 360 | 5093.9 | 4984.5 | 3937.0 |

* Velocities recorded photographically at 25-ft standoff

Fragment Velocities
Averaged for Both Firings
Test QD-155-S2

| Azimuthal Zone (°) | Velocity* (ft/sec) per Polar Zone (°) | | |
|---|---|---|---|
| | 90-95 | 95-100 | 100-105 |
| 0 - 10 | 3996.1 | 4249.0 | 4262.6 |
| 10 - 20 | 5637.4 | 5715.9 | 5479.0 |
| 20 - 30 | 5941.6 | 6310.2 | 5656.6 |
| 30 - 40 | 6379.0 | 6147.7 | 6006.9 |
| 40 - 50 | 5278.0 | 4793.6 | 5222.0 |
| 50 - 60 | 4016.6 | 4001.2 | 4356.1 |
| 60 - 70 | 3898.0 | 3976.5 | 3479.1 |
| 70 - 80 | 3981.1 | 4044.4 | 3486.0 |
| 80 - 90 | 3954.4 | 3631.6 | 3281.2 |
| 90 - 100 | 4034.5 | 3797.1 | 3456.6 |
| 100 - 110 | 4243.2 | 3823.1 | 3362.3 |
| 110 - 120 | 3870.2 | 3701.6 | 3586.0 |
| 120 - 130 | 4323.6 | 3704.1 | 3564.9 |
| 130 - 140 | 4911.0 | 4879.0 | 5189.2 |
| 140 - 150 | 5693.7 | 5712.9 | 5602.5 |
| 150 - 160 | 6617.0 | 6474.9 | 6666.7 |
| 160 - 170 | 6299.6 | 6174.7 | 6412.3 |
| 170 - 180 | 5441.8 | 4727.9 | 5222.8 |
| 180 - 190 | 3902.7 | 4935.7 | 4254.6 |
| 190 - 200 | 3813.3 | 3546.5 | 3334.6 |
| 200 - 210 | 4122.8 | 3527.9 | 3845.6 |
| 210 - 220 | 3969.4 | 3761.3 | 3717.5 |
| 220 - 230 | 3847.1 | 3791.4 | 3718.8 |
| 230 - 240 | 4088.0 | 3787.9 | 3452.4 |
| 240 - 250 | 3992.2 | 3478.2 | 3440.8 |
| 250 - 260 | 3834.5 | 4169.8 | 3593.5 |
| 260 - 270 | 3950.3 | 3836.5 | 3606.9 |
| 270 - 280 | 4024.8 | 4074.2 | 3538.8 |
| 280 - 290 | 3862.6 | 3729.9 | 3527.8 |
| 290 - 300 | 3953.1 | 3959.6 | 3195.9 |
| 300 - 310 | 3835.4 | 3696.7 | 3250.4 |
| 310 - 320 | 4147.2 | 3764.7 | 4021.9 |
| 320 - 330 | 4147.2 | 4216.5 | 3751.9 |
| 330 - 340 | 4080.6 | 4092.3 | 3759.0 |
| 340 - 350 | 3953.3 | 3956.2 | 3661.2 |
| 350 - 360 | 4888.2 | 4391.1 | 4001.2 |

* Velocities recorded photographically at 25-ft standoff

Fragment Hole Count Data
Firing No. 1
Test QD-155-S2

| Azimuthal Zone (°) | Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°) | | |
|---|---|---|---|
| | 90-95 | 95-100 | 100-105 |
| 0 - 5 | 12 | 11 | 14 |
| 5 - 10 | 15 | 21 | 20 |
| 10 - 15 | 11 | 33 | 32 |
| 15 - 20 | 22 | 33 | 30 |
| 20 - 25 | 28 | 26 | 32 |
| 25 - 30 | 30 | 23 | 18 |
| 30 - 35 | 31 | 25 | 23 |
| 35 - 40 | 20 | 24 | 29 |
| 40 - 45 | 15 | 17 | 18 |
| 45 - 50 | 10 | 9 | 11 |
| 50 - 55 | 8 | 7 | 5 |
| 55 - 60 | 5 | 6 | 5 |
| 60 - 65 | 4 | 5 | 5 |
| 65 - 70 | 5 | 6 | 4 |
| 70 - 75 | 3 | 5 | 5 |
| 75 - 80 | 4 | 4 | 4 |
| 80 - 85 | 5 | 3 | 3 |
| 85 - 90 | 5 | 6 | 7 |
| 90 - 95 | 4 | 4 | 6 |
| 95 - 100 | 5 | 5 | 5 |
| 100 - 105 | 6 | 7 | 5 |
| 105 - 110 | 6 | 4 | 4 |
| 110 - 115 | 5 | 7 | 7 |
| 115 - 120 | 4 | 8 | 7 |
| 120 - 125 | 5 | 5 | 6 |
| 125 - 130 | 12 | 13 | 14 |
| 130 - 135 | 16 | 17 | 14 |
| 135 - 140 | 19 | 18 | 20 |
| 140 - 145 | 30 | 28 | 32 |
| 145 - 150 | 37 | 16 | 23 |
| 150 - 155 | 32 | 19 | 24 |
| 155 - 160 | 15 | 20 | 26 |
| 160 - 165 | 10 | 31 | 17 |
| 165 - 170 | 8 | 24 | 34 |
| 170 - 175 | 10 | 16 | 21 |
| 175 - 180 | 11 | 19 | 16 |
| 180 - 185 | 12 | 29 | 16 |
| 185 - 190 | 11 | 12 | 13 |
| 190 - 195 | 9 | 8 | 12 |
| 195 - 200 | 6 | 7 | 9 |

Fragment Hole Count Data
Firing No. 1
Test QD-155-S2
(Continued)

| Azimuthal Zone (°) | Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°) | | |
|---|---|---|---|
| | 90-95 | 95-100 | 100-105 |
| 200 - 205 | 8 | 9 | 9 |
| 205 - 210 | 6 | 8 | 7 |
| 210 - 215 | 5 | 5 | 9 |
| 215 - 220 | 6 | 5 | 6 |
| 220 - 225 | 6 | 6 | 5 |
| 225 - 230 | 7 | 7 | 7 |
| 230 - 235 | 8 | 5 | 6 |
| 235 - 240 | 9 | 6 | 6 |
| 240 - 245 | 7 | 7 | 5 |
| 245 - 250 | 7 | 4 | 5 |
| 250 - 255 | 8 | 4 | 3 |
| 255 - 260 | 8 | 4 | 4 |
| 260 - 265 | 8 | 5 | 2 |
| 265 - 270 | 6 | 6 | 3 |
| 270 - 275 | 5 | 3 | 4 |
| 275 - 280 | 4 | 5 | 5 |
| 280 - 285 | 4 | 4 | 6 |
| 285 - 290 | 5 | 7 | 7 |
| 290 - 295 | 6 | 6 | 8 |
| 295 - 300 | 5 | 6 | 7 |
| 300 - 305 | 3 | 4 | 5 |
| 305 - 310 | 2 | 8 | 6 |
| 310 - 315 | 4 | 7 | 8 |
| 315 - 320 | 3 | 4 | 5 |
| 320 - 325 | 2 | 5 | 6 |
| 325 - 330 | 1 | 4 | 5 |
| 330 - 335 | 4 | 1 | 3 |
| 335 - 340 | 5 | 2 | 3 |
| 340 - 345 | 5 | 3 | 4 |
| 345 - 350 | 6 | 4 | 5 |
| 350 - 355 | 1 | 6 | 5 |
| 355 - 360 | 12 | 13 | 12 |

Fragment Hole Count Data
Firing No. 2
Test QD-155-S2

| Azimuthal Zone (°) | Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°) | | |
|---|---|---|---|
| | 90-95 | 95-100 | 100-105 |
| 0 - 5 | 6 | 24 | 15 |
| 5 - 10 | 7 | 20 | 16 |
| 10 - 15 | 11 | 21 | 19 |
| 15 - 20 | 9 | 29 | 17 |
| 20 - 25 | 17 | 28 | 33 |
| 25 - 30 | 20 | 29 | 39 |
| 30 - 35 | 25 | 13 | 36 |
| 35 - 40 | 35 | 23 | 21 |
| 40 - 45 | 21 | 25 | 20 |
| 45 - 50 | 17 | 27 | 45 |
| 50 - 55 | 10 | 11 | 9 |
| 55 - 60 | 13 | 12 | 10 |
| 60 - 65 | 5 | 4 | 6 |
| 65 - 70 | 6 | 6 | 7 |
| 70 - 75 | 4 | 4 | 7 |
| 75 - 80 | 5 | 5 | 6 |
| 80 - 85 | 4 | 10 | 9 |
| 85 - 90 | 5 | 11 | 12 |
| 90 - 95 | 4 | 12 | 11 |
| 95 - 100 | 6 | 8 | 8 |
| 100 - 105 | 5 | 10 | 9 |
| 105 - 110 | 8 | 7 | 8 |
| 110 - 115 | 7 | 6 | 9 |
| 115 - 120 | 8 | 7 | 6 |
| 120 - 125 | 4 | 4 | 5 |
| 125 - 130 | 3 | 4 | 5 |
| 130 - 135 | 4 | 5 | 4 |
| 135 - 140 | 5 | 6 | 6 |
| 140 - 145 | 6 | 6 | 10 |
| 145 - 150 | 24 | 26 | 27 |
| 150 - 155 | 26 | 32 | 18 |
| 155 - 160 | 23 | 24 | 18 |
| 160 - 165 | 34 | 25 | 24 |
| 165 - 170 | 28 | 15 | 24 |
| 170 - 175 | 22 | 24 | 32 |
| 175 - 180 | 22 | 23 | 23 |
| 180 - 185 | 12 | 21 | 17 |
| 185 - 190 | 8 | 31 | 28 |
| 190 - 195 | 16 | 21 | 15 |
| 195 - 200 | 12 | 11 | 9 |

Fragment Hole Count Data
Firing No. 2
Test QD-155-S2
(Continued)

| Azimuthal Zone (°) | Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°) | | |
|---|---|---|---|
| | 90-95 | 95-100 | 100-105 |
| 200 - 205 | 6 | 17 | 10 |
| 205 - 210 | 4 | 4 | 3 |
| 210 - 215 | 5 | 3 | 4 |
| 215 - 220 | 5 | 5 | 4 |
| 220 - 225 | 6 | 6 | 4 |
| 225 - 230 | 5 | 8 | 4 |
| 230 - 235 | 4 | 7 | 5 |
| 235 - 240 | 3 | 5 | 3 |
| 240 - 245 | 4 | 5 | 8 |
| 245 - 250 | 5 | 5 | 7 |
| 250 - 255 | 5 | 6 | 5 |
| 255 - 260 | 5 | 3 | 4 |
| 260 - 265 | 6 | 4 | 4 |
| 265 - 270 | 5 | 2 | 3 |
| 270 - 275 | 4 | 5 | 5 |
| 275 - 280 | 5 | 4 | 7 |
| 280 - 285 | 4 | 4 | 5 |
| 285 - 290 | 5 | 8 | 5 |
| 290 - 295 | 7 | 6 | 4 |
| 295 - 300 | 8 | 7 | 5 |
| 300 - 305 | 6 | 8 | 6 |
| 305 - 310 | 6 | 7 | 10 |
| 310 - 315 | 7 | 8 | 8 |
| 315 - 320 | 8 | 9 | 7 |
| 320 - 325 | 9 | 11 | 6 |
| 325 - 330 | 8 | 9 | 8 |
| 330 - 335 | 7 | 8 | 9 |
| 335 - 340 | 5 | 7 | 10 |
| 340 - 345 | 6 | 4 | 11 |
| 345 - 350 | 7 | 7 | 12 |
| 350 - 355 | 8 | 8 | 8 |
| 355 - 360 | 10 | 9 | 7 |

FRAGMENT HAZARD INVESTIGATION

Test Number: QD-155-S4

Item Tested: M107 155-mm projectile, 15-lb TNT

Configuration: Four projectiles vertically positioned, cube configuration, side-by-side, with the projectile centerline parallel and 7 in. apart

Number of Firings/Date: 2/14 July 1977

Location: NSWC/Experimental Explosive Area

Zone Information: Fragment hole count: 90 to 105° Polar
360° Azimuth

Meteorology: 14 July 1977
Barometric Pressure:
Temperature:

Instrumentation: Fragment velocity--five high-speed motion picture cameras, black and white film

Fragment Velocities
Averaged for Both Firings
Test QD-155-S4

| Azimuthal Zone (°) | Fragment Velocity* Averaged for Polar Zone 90-105° (ft/sec) |
|---|---|
| 0 - 10 | 3779 |
| 10 - 20 | 3885 |
| 20 - 30 | 4028 |
| 30 - 40 | 4478 |
| 40 - 50 | 5095 |
| 50 - 60 | 4556 |
| 60 - 70 | 4375 |
| 70 - 80 | 4010 |
| 80 - 90 | 4023 |
| 90 - 100 | 4288 |
| 100 - 110 | 4465 |
| 110 - 120 | 4480 |
| 120 - 130 | 4395 |
| 130 - 140 | 4185 |
| 140 - 150 | 4150 |
| 150 - 160 | 4075 |
| 160 - 170 | 4025 |
| 170 - 180 | 4400 |
| 180 - 190 | 4730 |
| 190 - 200 | 5190 |
| 200 - 210 | 5895 |
| 210 - 220 | 6300 |
| 220 - 230 | 4175 |
| 230 - 240 | 4200 |
| 240 - 250 | 5875 |
| 250 - 260 | 5950 |
| 260 - 270 | 6275 |
| 270 - 280 | 5392 |
| 280 - 290 | 4490 |
| 290 - 300 | 4180 |
| 300 - 310 | 4090 |
| 310 - 320 | 4430 |
| 320 - 330 | 5300 |
| 330 - 340 | 5510 |
| 340 - 350 | 5375 |
| 350 - 360 | 5120 |

* Velocities recorded photographically at 25-ft standoff

Fragment Hole Count Data
for Firing No. 1
Test QD-155-S4

| Azimuthal Zone (°) | Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°) | | |
|---|---|---|---|
| | 90-95 | 95-100 | 100-105 |
| 0 - 5 | 7 | 11 | 12 |
| 5 - 10 | 3 | 8 | 11 |
| 10 - 15 | 6 | 7 | 12 |
| 15 - 20 | 5 | 3 | 4 |
| 20 - 25 | 5 | 8 | 6 |
| 25 - 30 | 6 | 10 | 6 |
| 30 - 35 | 9 | 7 | 15 |
| 35 - 40 | 14 | 9 | 12 |
| 40 - 45 | 20 | 21 | 13 |
| 45 - 50 | 17 | 27 | 23 |
| 50 - 55 | 15 | 16 | 18 |
| 55 - 60 | 12 | 9 | 14 |
| 60 - 65 | 9 | 10 | 10 |
| 65 - 70 | 9 | 6 | 11 |
| 70 - 75 | 5 | 8 | 6 |
| 75 - 80 | 5 | 7 | 7 |
| 80 - 85 | 7 | 15 | 8 |
| 85 - 90 | 13 | 15 | 11 |
| 90 - 95 | 4 | 14 | 16 |
| 95 - 100 | 11 | 21 | 20 |
| 100 - 105 | 6 | 22 | 23 |
| 105 - 110 | 12 | 20 | 29 |
| 110 - 115 | 20 | 22 | 25 |
| 115 - 120 | 22 | 18 | 19 |
| 120 - 125 | 16 | 9 | 25 |
| 125 - 130 | 17 | 32 | 24 |
| 130 - 135 | 9 | 10 | 22 |
| 135 - 140 | 3 | 6 | 4 |
| 140 - 145 | 3 | 4 | 7 |
| 145 - 150 | 2 | 3 | 6 |
| 150 - 155 | 9 | 8 | 6 |
| 155 - 160 | 8 | 9 | 7 |
| 160 - 165 | 9 | 10 | 17 |
| 165 - 170 | 10 | 15 | 16 |
| 170 - 175 | 20 | 10 | 16 |
| 175 - 180 | 9 | 16 | 23 |
| 180 - 185 | 12 | 38 | 75 |
| 185 - 190 | 25 | 35 | 69 |
| 190 - 195 | 36 | 38 | 60 |
| 195 - 200 | 37 | 27 | 28 |

Fragment Hole Count Data
for Firing No. 1
Test QD-155-S4
(Continued)

| Azimuthal Zone (°) | Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°) | | |
|---|---|---|---|
| | 90-95 | 95-100 | 100-105 |
| 200 - 205 | 13 | 20 | 30 |
| 205 - 210 | 13 | 23 | 40 |
| 210 - 215 | 12 | 7 | 11 |
| 215 - 220 | 13 | 6 | 10 |
| 220 - 225 | 6 | 9 | 8 |
| 225 - 230 | 3 | 10 | 9 |
| 230 - 235 | 6 | 5 | 7 |
| 235 - 240 | 6 | 6 | 5 |
| 240 - 245 | 12 | 15 | 20 |
| 245 - 250 | 22 | 23 | 19 |
| 250 - 255 | 42 | 44 | 51 |
| 255 - 260 | 47 | 32 | 59 |
| 260 - 265 | 41 | 34 | 46 |
| 265 - 270 | 21 | 31 | 50 |
| 270 - 275 | 22 | 21 | 47 |
| 275 - 280 | 11 | 14 | 25 |
| 280 - 285 | 14 | 8 | 9 |
| 285 - 290 | 10 | 7 | 19 |
| 290 - 295 | 6 | 5 | 9 |
| 295 - 300 | 3 | 7 | 7 |
| 300 - 305 | 9 | 5 | 8 |
| 305 - 310 | 1 | 4 | 1 |
| 310 - 315 | 0 | 3 | 7 |
| 315 - 320 | 3 | 1 | 7 |
| 320 - 325 | 14 | 8 | 7 |
| 325 - 330 | 21 | 12 | 26 |
| 330 - 335 | 17 | 17 | 32 |
| 335 - 340 | 9 | 16 | 21 |
| 340 - 345 | 7 | 20 | 30 |
| 345 - 350 | 11 | 17 | 17 |
| 350 - 355 | 4 | 15 | 28 |
| 355 - 360 | 5 | 8 | 11 |

Fragment Hole Count Data
for Firing No. 2
Test QD-155-S4

| Azimuthal Zone (°) | Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°) | | |
|---|---|---|---|
| | 90-95 | 95-100 | 100-105 |
| 0 - 5 | 8 | 11 | 20 |
| 5 - 10 | 8 | 12 | 19 |
| 10 - 15 | 6 | 11 | 10 |
| 15 - 20 | 7 | 11 | 11 |
| 20 - 25 | 11 | 7 | 8 |
| 25 - 30 | 12 | 6 | 7 |
| 30 - 35 | 20 | 15 | 15 |
| 35 - 40 | 21 | 16 | 17 |
| 40 - 45 | 35 | 32 | 39 |
| 45 - 50 | 15 | 18 | 25 |
| 50 - 55 | 16 | 17 | 35 |
| 55 - 60 | 19 | 13 | 18 |
| 60 - 65 | 9 | 10 | 8 |
| 65 - 70 | 10 | 11 | 9 |
| 70 - 75 | 9 | 10 | 11 |
| 75 - 80 | 9 | 11 | 11 |
| 80 - 85 | 12 | 18 | 21 |
| 85 - 90 | 13 | 22 | 18 |
| 90 - 95 | 12 | 10 | 21 |
| 95 - 100 | 12 | 19 | 29 |
| 100 - 105 | 15 | 21 | 16 |
| 105 - 110 | 16 | 20 | 18 |
| 110 - 115 | 22 | 26 | 25 |
| 115 - 120 | 35 | 29 | 28 |
| 120 - 125 | 28 | 13 | 28 |
| 125 - 130 | 36 | 19 | 29 |
| 130 - 135 | 7 | 8 | 9 |
| 135 - 140 | 7 | 9 | 8 |
| 140 - 145 | 5 | 3 | 9 |
| 145 - 150 | 5 | 3 | 8 |
| 150 - 155 | 7 | 8 | 12 |
| 155 - 160 | 8 | 8 | 13 |
| 160 - 165 | 5 | 7 | 12 |
| 165 - 170 | 6 | 6 | 12 |
| 170 - 175 | 12 | 15 | 16 |
| 175 - 180 | 18 | 27 | 22 |
| 180 - 185 | 7 | 16 | 30 |
| 185 - 190 | 18 | 21 | 47 |
| 190 - 195 | 29 | 25 | 52 |
| 195 - 200 | 32 | 24 | 50 |

Fragment Hole Count Data
for Firing No. 2
Test QD-155-S4
(Continued)

| Azimuthal Zone (°) | Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°) | | |
|---|---|---|---|
| | 90-95 | 95-100 | 100-105 |
| 200 - 205 | 22 | 20 | 15 |
| 205 - 210 | 29 | 19 | 25 |
| 210 - 215 | 20 | 22 | 28 |
| 215 - 220 | 10 | 5 | 11 |
| 220 - 225 | 5 | 4 | 7 |
| 225 - 230 | 1 | 2 | 7 |
| 230 - 235 | 6 | 11 | 11 |
| 235 - 240 | 7 | 13 | 10 |
| 240 - 245 | 19 | 28 | 25 |
| 245 - 250 | 26 | 43 | 37 |
| 250 - 255 | 56 | 63 | 79 |
| 255 - 260 | 59 | 64 | 55 |
| 260 - 265 | 46 | 50 | 60 |
| 265 - 270 | 32 | 27 | 45 |
| 270 - 275 | 13 | 24 | 32 |
| 275 - 280 | 17 | 12 | 13 |
| 280 - 285 | 11 | 7 | 5 |
| 285 - 290 | 6 | 6 | 4 |
| 290 - 295 | 6 | 8 | 10 |
| 295 - 300 | 4 | 8 | 9 |
| 300 - 305 | 4 | 3 | 7 |
| 305 - 310 | 3 | 3 | 7 |
| 310 - 315 | 9 | 10 | 8 |
| 315 - 320 | 10 | 13 | 6 |
| 320 - 325 | 19 | 15 | 12 |
| 325 - 330 | 20 | 17 | 11 |
| 330 - 335 | 15 | 19 | 23 |
| 335 - 340 | 10 | 16 | 21 |
| 340 - 345 | 8 | 15 | 25 |
| 345 - 350 | 9 | 16 | 27 |
| 350 - 355 | 6 | 26 | 36 |
| 355 - 360 | 12 | 22 | 22 |

FRAGMENT HAZARD INVESTIGATION

Test Number: QD-155-S8

Item Tested: M107 155-mm projectile, 15-lb TNT

Configuration: Eight projectiles vertically positioned in a two-by-four matr
side-by-side, with the projectile centerline parallel and
7 in. apart.

Number of Firings/Date: 1/19 July 1977
1/21 July 1977

Location: NSWC/Explosive Experimental Area

Zone Information: Fragment hole count: 90 to 105° Polar
360° azimuth

Meteorology: 19 July 1977
Barometric Pressure: 29.70 in Hg
Temperature: 99°F
21 July 1977
Barometric Pressure: 28.75 in Hg
Temperature: 98°F

Instrumentation: Fragment velocity--five high-speed motion picture cameras,
black and white film

Fragment Velocities
Firing No. 1
Test QD-155-S8

| Azimuthal Zone (°) | Velocity* (ft/sec) per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 0 - 5 | 3046.3 | 4132.2 | 4027.1 |
| 5 - 10 | 4015.6 | 4137.0 | 3934.7 |
| 10 - 15 | 4545.8 | 4025.7 | 4401.6 |
| 15 - 20 | 4587.2 | 3775.1 | 4407.5 |
| 20 - 25 | 4326.1 | 4468.0 | 4350.8 |
| 25 - 30 | 4993.4 | 4433.4 | 4927.7 |
| 30 - 35 | 4907.8 | 4882.7 | 5344.2 |
| 35 - 40 | 4738.0 | 4852.8 | 5061.2 |
| 40 - 45 | 0.0 | 3984.3 | 3876.0 |
| 45 - 50 | 3506.2 | 3787.9 | 4389.0 |
| 50 - 55 | 0.0 | 4273.5 | 4273.5 |
| 55 - 60 | 3572.0 | 3545.6 | 0.0 |
| 60 - 65 | 3345.3 | 3981.8 | 3261.6 |
| 65 - 70 | 0.0 | 0.0 | 3261.6 |
| 70 - 75 | 3787.9 | 4038.8 | 3968.3 |
| 75 - 80 | 3877.6 | 3922.5 | 0.0 |
| 80 - 85 | 3679.7 | 3961.6 | 4920.6 |
| 85 - 90 | 4761.9 | 4733.0 | 5104.2 |
| 90 - 95 | 4977.5 | 5100.0 | 5420.3 |
| 95 - 100 | 5750.4 | 6137.7 | 5420.3 |
| 100 - 105 | 6146.1 | 6567.9 | 6172.8 |
| 105 - 110 | 6464.1 | 6267.7 | 6041.6 |
| 110 - 115 | 6410.3 | 6144.6 | 6393.6 |
| 115 - 120 | 5839.4 | 6085.1 | 6361.6 |
| 120 - 125 | 6085.1 | 6085.1 | 6554.1 |
| 125 - 130 | 4587.2 | 5187.7 | 5000.0 |
| 130 - 135 | 4424.8 | 4098.4 | 4587.2 |
| 135 - 140 | 3760.0 | 4237.3 | 4303.4 |
| 140 - 145 | 4386.0 | 4143.7 | 4098.4 |
| 145 - 150 | 4132.2 | 3789.2 | 4006.4 |
| 150 - 155 | 0.0 | 0.0 | 4166.7 |
| 155 - 160 | 0.0 | 0.0 | 0.0 |
| 160 - 165 | 0.0 | 3846.2 | 4858.5 |
| 165 - 170 | 5741.3 | 6725.0 | 7213.2 |
| 170 - 175 | 6687.5 | 7518.1 | 7050.5 |
| 175 - 180 | 6173.8 | 6137.9 | 6499.0 |
| 180 - 185 | 5651.7 | 4936.9 | 6131.8 |
| 185 - 190 | 0.0 | 0.0 | 4065.0 |
| 190 - 195 | 4166.7 | 4065.3 | 3906.3 |

* Velocities recorded photographically 25-ft standoff

Fragment Velocities
Firing No. 1
Test QD-155-S8
(Continued)

| Azimuthal Zone (°) | Velocity* (ft/sec) per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 195 - 200 | 4006.3 | 3919.8 | 3787.9 |
| 200 - 205 | 3968.3 | 3908.2 | 4132.2 |
| 205 - 210 | 3731.3 | 3943.1 | 3787.9 |
| 210 - 215 | 3731.3 | 4202.0 | 0.0 |
| 215 - 220 | 0.0 | 4347.8 | 0.0 |
| 220 - 225 | 3546.1 | 4056.6 | 4098.4 |
| 225 - 230 | 3378.4 | 4671.9 | 4237.3 |
| 230 - 235 | 0.0 | 4725.9 | 0.0 |
| 235 - 240 | 4902.0 | 5263.2 | 4854.4 |
| 240 - 245 | 5434.8 | 5662.2 | 5434.8 |
| 245 - 250 | 5421.9 | 5377.6 | 5681.8 |
| 250 - 255 | 4902.0 | 5050.5 | 5434.8 |
| 255 - 260 | 0.0 | 4761.9 | 5655.7 |
| 260 - 265 | 0.0 | 4578.8 | 0.0 |
| 265 - 270 | 0.0 | 0.0 | 0.0 |
| 270 - 275 | 0.0 | 0.0 | 0.0 |
| 275 - 280 | 0.0 | 0.0 | 0.0 |
| 280 - 285 | 0.0 | 0.0 | 0.0 |
| 285 - 290 | 0.0 | 4016.6 | 3787.9 |
| 290 - 295 | 0.0 | 3787.9 | 4240.0 |
| 295 - 300 | 0.0 | 4132.2 | 4132.2 |
| 300 - 305 | 0.0 | 3968.3 | 0.0 |
| 305 - 310 | 3571.4 | 4202.3 | 4132.2 |
| 310 - 315 | 0.0 | 3731.3 | 4237.3 |
| 315 - 320 | 4903.8 | 4587.2 | 4545.5 |
| 320 - 325 | 4903.2 | 5000.0 | 5104.2 |
| 325 - 330 | 4807.7 | 4479.1 | 4618.6 |
| 330 - 335 | 3968.3 | 3731.3 | 3976.2 |
| 335 - 340 | 3571.4 | 4065.0 | 4065.0 |
| 340 - 345 | 3571.4 | 4015.9 | 4056.6 |
| 345 - 350 | 3496.5 | 4083.1 | 4184.8 |
| 350 - 355 | 3247.4 | 3400.2 | 4237.3 |
| 355 - 360 | 3564.2 | 3514.4 | 4111.9 |

* Velocities recorded photographically 25-ft standoff

Fragment Velocities
Firing No. 2
Test QD-155-S8

| Azimuthal Zone (°) | Velocity* (ft/sec) per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 0 - 5 | 0.0 | 3546.1 | 4098.4 |
| 5 - 10 | 3012.0 | 3242.1 | 4367.6 |
| 10 - 15 | 3787.9 | 3994.8 | 4251.9 |
| 15 - 20 | 5077.3 | 5376.3 | 5202.4 |
| 20 - 25 | 4424.8 | 4424.8 | 4545.5 |
| 25 - 30 | 5159.6 | 5319.1 | 4951.0 |
| 30 - 35 | 5106.4 | 4750.0 | 5000.0 |
| 35 - 40 | 4762.3 | 4276.0 | 3978.7 |
| 40 - 45 | 4489.4 | 4374.1 | 3846.2 |
| 45 - 50 | 4098.4 | 0.0 | 4570.9 |
| 50 - 55 | 3571.4 | 4201.7 | 4237.3 |
| 55 - 60 | 3713.7 | 4335.6 | 4201.7 |
| 60 - 65 | 3500.4 | 0.0 | 3154.1 |
| 65 - 70 | 0.0 | 4137.7 | 4193.4 |
| 70 - 75 | 4201.7 | 4238.1 | 4411.5 |
| 75 - 80 | 3857.3 | 0.0 | 4473.2 |
| 80 - 85 | 3649.6 | 4118.4 | 4008.5 |
| 85 - 90 | 4587.2 | 4858.5 | 4757.4 |
| 90 - 95 | 4918.5 | 4950.5 | 5058.8 |
| 95 - 100 | 4950.5 | 4950.5 | 5302.4 |
| 100 - 105 | 5895.4 | 5747.1 | 6142.3 |
| 105 - 110 | 6014.1 | 6410.3 | 6050.7 |
| 110 - 115 | 5889.0 | 6078.7 | 5747.1 |
| 115 - 120 | 5682.6 | 6538.5 | 6331.1 |
| 120 - 125 | 5682.6 | 5747.1 | 6410.3 |
| 125 - 130 | 5618.0 | 6337.4 | 6362.8 |
| 130 - 135 | 5050.5 | 4979.3 | 5283.8 |
| 135 - 140 | 4166.7 | 3832.5 | 4166.7 |
| 140 - 145 | 3780.5 | 4082.3 | 3877.1 |
| 145 - 150 | 3668.4 | 3665.5 | 4237.3 |
| 150 - 155 | 3521.1 | 4272.9 | 4166.7 |
| 155 - 160 | 3223.5 | 4138.3 | 4386.0 |
| 160 - 165 | 4950.5 | 4717.0 | 7352.9 |
| 165 - 170 | 6899.5 | 7721.6 | 7815.7 |
| 170 - 175 | 7882.6 | 7745.9 | 7367.4 |
| 175 - 180 | 6651.5 | 5611.2 | 6095.8 |
| 180 - 185 | 5142.2 | 4807.7 | 5440.6 |
| 185 - 190 | 4065.0 | 4331.0 | 0.0 |
| 190 - 195 | 3571.6 | 4420.3 | 4545.5 |

* Velocities recorded photographically at 25-ft standoff

Fragment Velocities
Firing No. 2
Test QD-155-S8
(Continued)

| Azimuthal Zone (°) | Velocity* (ft/sec) per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 195 - 200 | 0.0 | 3981.3 | 4166.7 |
| 200 - 205 | 0.0 | 0.0 | 0.0 |
| 205 - 210 | 4237.3 | 4159.7 | 0.0 |
| 210 - 215 | 4386.0 | 4244.5 | 4201.7 |
| 215 - 220 | 0.0 | 0.0 | 0.0 |
| 220 - 225 | 0.0 | 4032.3 | 0.0 |
| 225 - 230 | 5434.8 | 4246.7 | 5400.5 |
| 230 - 235 | 5438.6 | 5529.3 | 4854.4 |
| 235 - 240 | 5618.0 | 5050.5 | 5050.5 |
| 240 - 245 | 4761.9 | 4587.2 | 4797.0 |
| 245 - 250 | 4347.8 | 4902.0 | 4693.4 |
| 250 - 255 | 4321.9 | 4347.8 | 4902.9 |
| 255 - 260 | 4386.0 | 4239.1 | 4347.8 |
| 260 - 265 | 3530.6 | 4281.3 | 4154.8 |
| 265 - 270 | 3766.0 | 3624.9 | 3958.8 |
| 270 - 275 | 3257.7 | 3274.2 | 3911.2 |
| 275 - 280 | 0.0 | 3227.0 | 3827.8 |
| 280 - 285 | 0.0 | 0.0 | 0.0 |
| 285 - 290 | 3276.9 | 3999.6 | 4322.8 |
| 290 - 295 | 3076.2 | 3646.5 | 3941.8 |
| 295 - 300 | 3787.9 | 3135.1 | 4329.1 |
| 300 - 305 | 3760.6 | 4033.3 | 4201.7 |
| 305 - 310 | 3760.6 | 3521.1 | 4201.7 |
| 310 - 315 | 4761.9 | 4313.2 | 4201.7 |
| 315 - 320 | 4587.2 | 4717.0 | 4587.2 |
| 320 - 325 | 4587.5 | 4854.4 | 4629.6 |
| 325 - 330 | 4464.3 | 4761.9 | 4545.5 |
| 330 - 335 | 0.0 | 4201.7 | 3993.4 |
| 335 - 340 | 4201.7 | 4049.1 | 3848.7 |
| 340 - 345 | 3472.2 | 4100.8 | 4310.3 |
| 345 - 350 | 3125.0 | 3720.3 | 4256.0 |
| 350 - 355 | 3246.8 | 3550.5 | 3787.9 |
| 355 - 360 | 3414.2 | 3659.0 | 3715.4 |

* Velocities recorded photographically at 25-ft standoff

Fragment Velocities
Averaged for Both Firings
Test QD-155-S8

| Azimuthal Zone (°) | Velocity* (ft/sec) per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 0 - 5 | 3046.3 | 3839.2 | 4039.0 |
| 5 - 10 | 3681.8 | 3881.3 | 4107.9 |
| 10 - 15 | 4166.9 | 4017.5 | 4345.5 |
| 15 - 20 | 4913.9 | 4461.3 | 4748.2 |
| 20 - 25 | 4375.4 | 4455.7 | 4415.7 |
| 25 - 30 | 5040.9 | 4581.0 | 4934.4 |
| 30 - 35 | 4982.3 | 4823.7 | 5286.8 |
| 35 - 40 | 4744.9 | 4605.6 | 4655.2 |
| 40 - 45 | 4489.4 | 4211.7 | 3861.1 |
| 45 - 50 | 3703.6 | 3787.9 | 4479.9 |
| 50 - 55 | 3571.4 | 4237.6 | 4255.4 |
| 55 - 60 | 3642.9 | 3861.6 | 4201.7 |
| 60 - 65 | 3438.4 | 3981.8 | 3154.1 |
| 65 - 70 | 0.0 | 4143.7 | 3927.2 |
| 70 - 75 | 3994.8 | 4181.2 | 4337.6 |
| 75 - 80 | 3869.5 | 3922.5 | 4473.2 |
| 80 - 85 | 3669.6 | 4040.0 | 4464.6 |
| 85 - 90 | 4674.5 | 4768.9 | 4896.1 |
| 90 - 95 | 4955.4 | 5025.2 | 5364.4 |
| 95 - 100 | 5617.1 | 5939.8 | 5376.1 |
| 100 - 105 | 6074.5 | 6431.1 | 6164.1 |
| 105 - 110 | 6335.6 | 6333.9 | 6044.2 |
| 110 - 115 | 6019.3 | 6125.8 | 6285.8 |
| 115 - 120 | 5776.7 | 6214.6 | 6350.2 |
| 120 - 125 | 5970.1 | 5988.5 | 6496.6 |
| 125 - 130 | 5102.6 | 5680.5 | 5973.4 |
| 130 - 135 | 4894.1 | 4853.5 | 5005.2 |
| 135 - 140 | 3861.7 | 3933.7 | 4269.2 |
| 140 - 145 | 3901.6 | 4102.7 | 3921.4 |
| 145 - 150 | 3745.7 | 3727.3 | 4083.4 |
| 150 - 155 | 3521.1 | 4272.9 | 4166.7 |
| 155 - 160 | 3223.5 | 4138.3 | 4386.0 |
| 160 - 165 | 4950.5 | 4281.6 | 5690.0 |
| 165 - 170 | 6320.4 | 7306.3 | 7614.9 |
| 170 - 175 | 7339.3 | 7654.8 | 7209.0 |
| 175 - 180 | 6412.6 | 5850.6 | 6319.8 |
| 180 - 185 | 5397.0 | 4904.6 | 5786.2 |
| 185 - 190 | 4065.0 | 5331.0 | 4065.0 |
| 190 - 195 | 3770.0 | 4278.3 | 4225.9 |

* Velocities recorded photographically at 25-ft standoff

Fragment Velocities
Averaged for Both Firings
Test QD-155-S8
(Continued)

| Azimuthal Zone (°) | Velocity* (ft/sec) per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 195 - 200 | 4006.3 | 3942.9 | 3977.3 |
| 200 - 205 | 3968.3 | 3908.2 | 4132.2 |
| 205 - 210 | 3984.3 | 4015.3 | 3787.9 |
| 210 - 215 | 4058.7 | 4216.1 | 4201.7 |
| 215 - 220 | 0.0 | 4347.8 | 0.0 |
| 220 - 225 | 3546.1 | 4048.5 | 4098.4 |
| 225 - 230 | 4063.8 | 5165.9 | 5206.6 |
| 230 - 235 | 5438.6 | 5368.6 | 4854.4 |
| 235 - 240 | 5260.0 | 5192.3 | 5001.5 |
| 240 - 245 | 5098.3 | 5303.9 | 5052.1 |
| 245 - 250 | 5153.4 | 5258.7 | 5117.0 |
| 250 - 255 | 4515.3 | 4816.3 | 5168.8 |
| 255 - 260 | 4386.0 | 4413.4 | 5328.7 |
| 260 - 265 | 3530.6 | 4380.5 | 4154.8 |
| 265 - 270 | 3766.0 | 3624.9 | 3958.8 |
| 270 - 275 | 3257.7 | 3234.2 | 3811.2 |
| 275 - 280 | 0.0 | 3227.0 | 3827.8 |
| 280 - 285 | 0.0 | 0.0 | 0.0 |
| 285 - 290 | 3276.9 | 4004.5 | 4108.9 |
| 290 - 295 | 3076.2 | 3674.8 | 4008.0 |
| 295 - 300 | 3787.9 | 3467.5 | 4263.5 |
| 300 - 305 | 3760.6 | 4011.6 | 4201.7 |
| 305 - 310 | 3666.0 | 3929.8 | 4167.0 |
| 310 - 315 | 4761.9 | 4119.3 | 4219.5 |
| 315 - 320 | 4798.3 | 4652.1 | 4566.3 |
| 320 - 325 | 4776.9 | 4927.2 | 4946.0 |
| 325 - 330 | 4636.0 | 4549.8 | 4594.2 |
| 330 - 335 | 3960.3 | 3966.5 | 3983.1 |
| 335 - 340 | 3991.6 | 4054.4 | 3935.2 |
| 340 - 345 | 3521.8 | 4040.1 | 4141.2 |
| 345 - 350 | 3248.8 | 3901.7 | 4220.4 |
| 350 - 355 | 3247.2 | 3486.1 | 4087.5 |
| 355 - 360 | 3489.2 | 3576.4 | 3874.0 |

* Velocities recorded photographically at 25-ft standoff

Fragment Hole Count Data
Firing No. 1
Test QD-155-S8

| Azimuthal Zone (°) | Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 0 - 5 | 11 | 13 | 19 |
| 5 - 10 | 18 | 23 | 16 |
| 10 - 15 | 9 | 21 | 25 |
| 15 - 20 | 22 | 20 | 44 |
| 20 - 25 | 18 | 19 | 29 |
| 25 - 30 | 32 | 16 | 22 |
| 30 - 35 | 10 | 12 | 39 |
| 35 - 40 | 24 | 14 | 15 |
| 40 - 45 | 5 | 4 | 5 |
| 45 - 50 | 5 | 4 | 5 |
| 50 - 55 | 7 | 5 | 4 |
| 55 - 60 | 3 | 6 | 6 |
| 60 - 65 | 11 | 7 | 12 |
| 65 - 70 | 10 | 8 | 17 |
| 70 - 75 | 11 | 13 | 20 |
| 75 - 80 | 18 | 20 | 19 |
| 80 - 85 | 24 | 19 | 25 |
| 85 - 90 | 33 | 36 | 50 |
| 90 - 95 | 47 | 43 | 56+ |
| 95 - 100 | 76 | 49 | 99+ |
| 100 - 105 | 56 | 51 | 83+ |
| 105 - 110 | 69 | 41 | 80 |
| 110 - 115 | 55 | 38 | 46 |
| 115 - 120 | 63 | 35 | 106 |
| 120 - 125 | 106 | 110 | 160 |
| 125 - 130 | 103 | 126 | 138 |
| 130 - 135 | 23 | 19 | 24 |
| 135 - 140 | 3 | 4 | 9 |
| 140 - 145 | 4 | 5 | 10 |
| 145 - 150 | 2 | 5 | 5 |
| 150 - 155 | 4 | 7 | 7 |
| 155 - 160 | 3 | 2 | 2 |
| 160 - 165 | 6 | 14 | 6 |
| 165 - 170 | 63 | 73 | 49 |
| 170 - 175 | 93 | 203 | 205 |
| 175 - 180 | 77 | 125 | 113 |
| 180 - 185 | 28 | 33 | 65 |
| 185 - 190 | 15 | 14 | 24 |
| 190 - 195 | 7 | 5 | 12 |
| 195 - 200 | 7 | 8 | 8 |
| 200 - 205 | 8 | 8 | 8 |

Fragment Hole Count Data
Firing No. 1
Test QD-155-S8
(Continued)

| Azimuthal Zone (°) | Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 205 - 210 | 13 | 21 | 5 |
| 210 - 215 | 6 | 6 | 7 |
| 215 - 220 | 2 | 7 | 8 |
| 220 - 225 | 3 | 7 | 4 |
| 225 - 230 | 8 | 4 | 11 |
| 230 - 235 | 35 | 37 | 22 |
| 235 - 240 | 63 | 34 | 53 |
| 240 - 245 | 66 | 43 | 99 |
| 245 - 250 | 74 | 47 | 74 |
| 250 - 255 | 60 | 39 | 97 |
| 255 - 260 | 25 | 37 | 64+ |
| 260 - 265 | 32 | 43 | 62 |
| 265 - 270 | 43 | 44 | 46 |
| 270 - 275 | 38 | 44 | 30 |
| 275 - 280 | 26 | 29 | 33 |
| 280 - 285 | 20 | 26 | 12 |
| 285 - 290 | 19 | 23 | 13 |
| 290 - 295 | 15 | 13 | 11 |
| 295 - 300 | 12 | 14 | 7 |
| 300 - 305 | 15 | 11 | 7 |
| 305 - 310 | 17 | 17 | 9 |
| 310 - 315 | 21 | 23 | 16 |
| 315 - 320 | 29 | 37 | 25 |
| 320 - 325 | 39 | 46 | 28 |
| 325 - 330 | 30 | 36 | 23 |
| 330 - 335 | 16 | 17 | 13 |
| 335 - 340 | 11 | 9 | 5 |
| 340 - 345 | 14 | 12 | 10 |
| 345 - 350 | 6 | 8 | 5 |
| 350 - 355 | 6 | 8 | 5 |
| 355 - 360 | 7 | 13 | 8 |

Fragment Hole Count Data
Firing No. 2
Test QD-155-S8

| Azimuthal Zone (°) | Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 0 - 5 | 7 | 11 | 19 |
| 5 - 10 | 12 | 24 | 19 |
| 10 - 15 | 12 | 19 | 26 |
| 15 - 20 | 8 | 16 | 42 |
| 20 - 25 | 9 | 14 | 27 |
| 25 - 30 | 20 | 14 | 26 |
| 30 - 35 | 11 | 21 | 40 |
| 35 - 40 | 10 | 16 | 17 |
| 40 - 45 | 1 | 7 | 9 |
| 45 - 50 | 6 | 4 | 6 |
| 50 - 55 | 6 | 3 | 8 |
| 55 - 60 | 5 | 11 | 10 |
| 60 - 65 | 7 | 6 | 10 |
| 65 - 70 | 14 | 15 | 24 |
| 70 - 75 | 7 | 14 | 21 |
| 75 - 80 | 14 | 15 | 20 |
| 80 - 85 | 33 | 22 | 33 |
| 85 - 90 | 36 | 54 | 50+ |
| 90 - 95 | 53 | 53 | 95 |
| 95 - 100 | 42 | 70 | 96 |
| 100 - 105 | 86 | 46 | 78 |
| 105 - 110 | 39 | 38 | 112 |
| 110 - 115 | 34 | 49 | 94 |
| 115 - 120 | 52 | 76 | 143 |
| 120 - 125 | 76 | 73 | 115 |
| 125 - 130 | 113 | 82 | 105 |
| 130 - 135 | 68 | 71 | 33 |
| 135 - 140 | 10 | 15 | 6 |
| 140 - 145 | 15 | 14 | 8 |
| 145 - 150 | 9 | 8 | 16 |
| 150 - 155 | 2 | 11 | 11 |
| 155 - 160 | 5 | 15 | 5 |
| 160 - 165 | 12 | 23 | 23 |
| 165 - 170 | 72 | 113 | 89 |
| 170 - 175 | 122 | 155 | 195 |
| 175 - 180 | 64 | 81 | 166 |
| 180 - 185 | 23 | 31 | 65 |
| 185 - 190 | 11 | 12 | 19 |
| 190 - 195 | 6 | 15 | 16 |
| 195 - 200 | 3 | 9 | * |
| 200 - 205 | 6 | 12 | 5 |

Fragment Hole Count Data
Firing No. 2
Test QD-155-S8
(Continued)

| Azimuthal Zone (°) | Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 205 - 210 | 3 | 4 | 4 |
| 210 - 215 | 6 | 5 | 7 |
| 215 - 220 | 4 | 5 | 9 |
| 220 - 225 | 3 | 5 | 6 |
| 225 - 230 | 31 | 28 | 10 |
| 230 - 235 | 44 | 53 | 36 |
| 235 - 240 | 42 | 52 | 108 |
| 240 - 245 | 62 | 43 | 59 |
| 245 - 250 | 29 | 24 | 61 |
| 250 - 255 | 33 | 47 | 55 |
| 255 - 260 | 40 | 64 | 62 |
| 260 - 265 | 28 | 61 | 46 |
| 265 - 270 | 29 | 60 | 31 |
| 270 - 275 | 15 | 35 | 35 |
| 275 - 280 | 19 | 23 | 27 |
| 280 - 285 | 12 | 8 | 12 |
| 285 - 290 | 16 | 13 | 13 |
| 290 - 295 | 20 | 21 | 9 |
| 295 - 300 | 20 | 11 | 7 |
| 300 - 305 | 17 | 13 | 16 |
| 305 - 310 | 17 | 11 | 15 |
| 310 - 315 | 30 | 17 | 17 |
| 315 - 320 | 41 | 46 | 28 |
| 320 - 325 | 44 | 52 | 29 |
| 325 - 330 | 25 | 22 | 26 |
| 330 - 335 | 11 | 8 | 14 |
| 335 - 340 | 15 | 13 | 15 |
| 340 - 345 | 6 | 8 | 5 |
| 345 - 350 | 8 | 9 | 9 |
| 350 - 355 | 5 | 15 | 13 |
| 355 - 360 | 10 | 17 | 22 |

FRAGMENT HAZARD INVESTIGATION

Test Number: QD-155-S8A

Item Tested: M107 155-mm projectile, 15-lb TNT

Configuration: Eight projectiles vertically positioned, two-by-four matrix, side-by-side, with the projectile centerline parallel and 7 in. apart

Numbr of Firings/Date: 1/28 July 1977
1/4 August 1977

Location: NSWC/Explosive Experimental Area

Zone Information: Fragment hole count: 90 to 105° Polar
360° Azimuth

Meteorology: 28 July 1977
Barometric Pressure: 28.45 in Hg
Temperature: 88°F
4 August 1977
Barometric Pressure: 29.95 in Hg
Temperature: 98°F

Instrumentation: Fragment velocity--five high-speed motion picture cameras, black and white film

Fragment Velocities
Firing No. 1
Test QD-155-S8A

| Azimuthal Zone (°) | Velocity* (ft/sec) per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 0 - 5 | 3816.8 | 4347.8 | 3114.3 |
| 5 - 10 | 4464.3 | 3728.1 | 5146.6 |
| 10 - 15 | 5046.1 | 4317.3 | 5436.1 |
| 15 - 20 | 5423.9 | 5073.4 | 5497.6 |
| 20 - 25 | 5292.3 | 5056.2 | 5103.7 |
| 25 - 30 | 6172.8 | 6410.3 | 5580.4 |
| 30 - 35 | 5849.8 | 5815.5 | 5465.9 |
| 35 - 40 | 5555.6 | 5376.3 | 4902.0 |
| 40 - 45 | 5347.1 | 5555.6 | 4525.0 |
| 45 - 50 | 3846.2 | 4357.4 | 3869.0 |
| 50 - 55 | 3589.2 | 4260.6 | 3460.6 |
| 55 - 60 | 5121.7 | 4854.4 | 4098.4 |
| 60 - 65 | 5814.0 | 4816.0 | 6538.5 |
| 65 - 70 | 6805.6 | 6672.0 | 4583.5 |
| 70 - 75 | 6550.2 | 6079.2 | 6607.7 |
| 75 - 80 | 5434.8 | 5915.3 | 5906.8 |
| 80 - 85 | 4939.3 | 6396.2 | 4951.5 |
| 85 - 90 | 6454.0 | 4902.0 | 4723.7 |
| 90 - 95 | 5428.8 | 4629.6 | 4784.4 |
| 95 - 100 | 4850.4 | 4902.0 | 4812.8 |
| 100 - 105 | 6559.9 | 5618.0 | 5167.5 |
| 105 - 110 | 5306.7 | 5618.0 | 5977.4 |
| 110 - 115 | 6097.6 | 5681.8 | 5618.0 |
| 115 - 120 | 4950.5 | 5263.2 | 4541.4 |
| 120 - 125 | 5452.6 | 4809.4 | 5263.2 |
| 125 - 130 | 5452.6 | 5102.0 | 4717.0 |
| 130 - 135 | 4954.9 | 4905.8 | 4545.8 |
| 135 - 140 | 4099.5 | 4807.7 | 3834.2 |
| 140 - 145 | 4000.0 | 4251.7 | 4386.0 |
| 145 - 150 | 4006.4 | 4214.6 | 4386.0 |
| 150 - 155 | 3968.3 | 4166.7 | 4223.1 |
| 155 - 160 | 5924.0 | 6222.9 | 6087.7 |
| 160 - 165 | 6493.5 | 6583.7 | 6719.0 |
| 165 - 170 | 7462.7 | 6944.4 | 7375.8 |
| 170 - 175 | 5681.8 | 6493.5 | 6944.4 |
| 175 - 180 | 4902.0 | 5246.1 | 5398.1 |
| 180 - 185 | 4742.9 | 4262.6 | 4583.8 |
| 185 - 190 | 4629.6 | 3693.4 | 3246.8 |
| 190 - 195 | 0.0 | 3844.1 | 3401.4 |

* Velocities recorded photographically at 25-ft standoff

Fragment Velocities
Firing No. 1
Test QD-155-S8A
(Continued)

| Azimuthal Zone (°) | Velocity* (ft/sec) per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 195 - 200 | 4131.9 | 4069.4 | 3734.3 |
| 200 - 205 | 4280.5 | 4406.1 | 0.0 |
| 205 - 210 | 4350.8 | 4219.6 | 0.0 |
| 210 - 215 | 4098.4 | 3703.7 | 4132.2 |
| 215 - 220 | 4347.8 | 0.0 | 3937.0 |
| 220 - 225 | 4311.0 | 3937.0 | 3703.7 |
| 225 - 230 | 3811.0 | 4000.0 | 3434.4 |
| 230 - 235 | 3918.5 | 3906.3 | 4386.0 |
| 235 - 240 | 4467.1 | 4902.0 | 4347.8 |
| 240 - 245 | 4609.2 | 4761.9 | 4587.2 |
| 245 - 250 | 5102.0 | 4717.0 | 4672.9 |
| 250 - 255 | 5618.0 | 4950.5 | 4593.3 |
| 255 - 260 | 5102.0 | 4545.5 | 4310.3 |
| 260 - 265 | 6666.7 | 4310.3 | 5000.0 |
| 265 - 270 | 4761.9 | 4391.4 | 4464.3 |
| 270 - 275 | 4672.9 | 4464.3 | 4237.3 |
| 275 - 280 | 4629.6 | 4545.5 | 4746.9 |
| 280 - 285 | 5102.0 | 4237.3 | 4525.0 |
| 285 - 290 | 4807.7 | 4587.2 | 4717.0 |
| 290 - 295 | 4960.9 | 5102.0 | 5000.0 |
| 295 - 300 | 5376.3 | 5376.3 | 5376.3 |
| 300 - 305 | 5376.3 | 5182.6 | 5263.2 |
| 305 - 310 | 4854.4 | 5376.3 | 5263.2 |
| 310 - 315 | 4527.2 | 4004.1 | 0.0 |
| 315 - 320 | 4310.3 | 3745.8 | 4237.3 |
| 320 - 325 | 3623.2 | 3968.3 | 3098.4 |
| 325 - 330 | 4097.8 | 4006.6 | 0.0 |
| 330 - 335 | 3701.4 | 3270.5 | 0.0 |
| 335 - 340 | 3048.3 | 3632.7 | 3273.8 |
| 340 - 345 | 4098.4 | 2873.6 | 0.0 |
| 345 - 350 | 4098.4 | 3564.3 | 3355.7 |
| 350 - 355 | 3954.0 | 3423.5 | 3424.7 |
| 355 - 360 | 4098.4 | 3418.2 | 3227.5 |

* Velocities recorded photographically at 25-ft standoff

Fragment Velocities
Firing No. 2
Test QD-155-S8A

| Azimuthal Zone (°) | Velocity* (ft/sec) per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 0 - 5 | 3559.9 | 3985.5 | 4212.9 |
| 5 - 10 | 5102.0 | 4629.6 | 5349.0 |
| 10 - 15 | 5263.2 | 6189.6 | 5671.8 |
| 15 - 20 | 6593.0 | 6187.8 | 6258.0 |
| 20 - 25 | 6466.5 | 6097.6 | 5263.2 |
| 25 - 30 | 5690.7 | 4984.2 | 4950.5 |
| 30 - 35 | 3597.1 | 4274.4 | 3763.0 |
| 35 - 40 | 3597.1 | 3849.8 | 3164.6 |
| 40 - 45 | 4166.7 | 4020.2 | 2977.9 |
| 45 - 50 | 3164.6 | 4191.8 | 4587.2 |
| 50 - 55 | 5035.9 | 4231.8 | 3648.4 |
| 55 - 60 | 5884.5 | 5237.1 | 4168.4 |
| 60 - 65 | 6178.6 | 5982.1 | 5620.5 |
| 65 - 70 | 5741.0 | 5868.3 | 5927.8 |
| 70 - 75 | 4807.7 | 4525.7 | 4711.8 |
| 75 - 80 | 4790.1 | 4505.2 | 4347.8 |
| 80 - 85 | 4807.7 | 4717.0 | 4792.4 |
| 85 - 90 | 4950.5 | 4761.9 | 4464.3 |
| 90 - 95 | 5210.6 | 5102.0 | 4563.5 |
| 95 - 100 | 5437.4 | 5555.6 | 5001.0 |
| 100 - 105 | 6744.5 | 6671.4 | 6223.2 |
| 105 - 110 | 6588.2 | 6434.7 | 6260.2 |
| 110 - 115 | 6498.8 | 6396.1 | 5952.4 |
| 115 - 120 | 6490.5 | 5064.5 | 4950.5 |
| 120 - 125 | 5960.6 | 5811.3 | 5588.7 |
| 125 - 130 | 6493.5 | 5479.4 | 5151.1 |
| 130 - 135 | 4464.3 | 4275.5 | 3496.5 |
| 135 - 140 | 4081.7 | 4193.5 | 4237.3 |
| 140 - 145 | 3878.1 | 4237.3 | 3653.2 |
| 145 - 150 | 3731.3 | 4386.0 | 3825.7 |
| 150 - 155 | 4717.0 | 4605.8 | 3355.7 |
| 155 - 160 | 5154.6 | 5017.0 | 4504.5 |
| 160 - 165 | 7091.5 | 6849.3 | 6172.8 |
| 165 - 170 | 8007.4 | 8151.7 | 7885.8 |
| 170 - 175 | 7129.7 | 7424.7 | 7110.3 |
| 175 - 180 | 5134.8 | 5573.8 | 5102.0 |
| 180 - 185 | 5406.8 | 4970.9 | 4347.8 |
| 185 - 190 | 3745.4 | 3556.9 | 3216.7 |
| 190 - 195 | 3705.0 | 3784.6 | 3546.1 |

* Velocities recorded photographically at 25-ft standoff

Fragment Velocities
Firing No. 2
Test QD-155-S8A
(Continued)

| Azimuthal Zone (°) | Velocity* (ft/sec) per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 195 - 200 | 4187.2 | 3877.4 | 3462.4 |
| 200 - 205 | 4175.3 | 4206.4 | 2857.1 |
| 205 - 210 | 0.0 | 3787.9 | 3414.7 |
| 210 - 215 | 4387.3 | 4310.3 | 3246.8 |
| 215 - 220 | 4387.3 | 3355.7 | 4152.8 |
| 220 - 225 | 4505.2 | 4201.7 | 3846.2 |
| 225 - 230 | 4696.8 | 4375.2 | 4098.4 |
| 230 - 235 | 5500.5 | 5154.6 | 5082.0 |
| 235 - 240 | 5197.2 | 5236.9 | 5077.3 |
| 240 - 245 | 5330.4 | 5000.0 | 5025.3 |
| 245 - 250 | 5236.9 | 5274.6 | 4985.5 |
| 250 - 255 | 4974.4 | 5025.3 | 5102.0 |
| 255 - 260 | 4601.8 | 4310.6 | 4902.0 |
| 260 - 265 | 4717.0 | 4513.7 | 5208.3 |
| 265 - 270 | 4720.8 | 4494.9 | 4717.0 |
| 270 - 275 | 4717.0 | 4632.7 | 4940.7 |
| 275 - 280 | 4227.0 | 4587.2 | 4807.7 |
| 280 - 285 | 4294.5 | 4285.7 | 4717.0 |
| 285 - 290 | 4587.2 | 4687.4 | 4386.0 |
| 290 - 295 | 4006.0 | 4927.2 | 4882.8 |
| 295 - 300 | 4949.5 | 4831.0 | 4761.9 |
| 300 - 305 | 5319.1 | 5434.8 | 5376.3 |
| 305 - 310 | 5154.6 | 5263.2 | 5154.6 |
| 310 - 315 | 4950.5 | 4954.9 | 5050.5 |
| 315 - 320 | 4132.2 | 4761.9 | 4950.5 |
| 320 - 325 | 3846.2 | 4545.5 | 4201.7 |
| 325 - 330 | 0.0 | 4386.0 | 4098.4 |
| 330 - 335 | 0.0 | 4132.2 | 3816.8 |
| 335 - 340 | 4573.9 | 3379.0 | 3333.3 |
| 340 - 345 | 3816.8 | 3978.7 | 4000.0 |
| 345 - 350 | 4386.0 | 3906.3 | 3184.7 |
| 350 - 355 | 4237.3 | 3710.9 | 3407.4 |
| 355 - 360 | 5000.0 | 3778.3 | 3864.5 |

* Velocities recorded photographically at 25-ft standoff

Fragment Velocities
Averaged for Both Firings
Test QD-155-S8A

| Azimuthal Zone (°) | Velocity* (ft/sec) per Polar Zone (°) | | |
|---|---|---|---|
| | 90-95 | 95-100 | 100-105 |
| 0 - 5 | 3688.3 | 4130.4 | 3585.1 |
| 5 - 10 | 4889.5 | 3908.4 | 5214.0 |
| 10 - 15 | 5082.3 | 4852.3 | 5553.9 |
| 15 - 20 | 6073.4 | 5551.0 | 5877.8 |
| 20 - 25 | 5996.8 | 5403.3 | 5167.5 |
| 25 - 30 | 5828.4 | 5554.6 | 5370.4 |
| 30 - 35 | 5399.2 | 4934.9 | 4330.6 |
| 35 - 40 | 4576.3 | 4358.6 | 4033.3 |
| 40 - 45 | 5111.0 | 4327.2 | 3751.4 |
| 45 - 50 | 3505.4 | 4274.6 | 4108.4 |
| 50 - 55 | 4553.7 | 4243.3 | 3585.8 |
| 55 - 60 | 5598.5 | 5127.7 | 4133.4 |
| 60 - 65 | 6117.8 | 5399.0 | 5882.8 |
| 65 - 70 | 6045.1 | 6327.5 | 5543.7 |
| 70 - 75 | 6052.3 | 5302.4 | 5659.7 |
| 75 - 80 | 5219.9 | 5210.2 | 5595.0 |
| 80 - 85 | 4906.4 | 5836.5 | 4872.0 |
| 85 - 90 | 5952.9 | 4831.9 | 4568.1 |
| 90 - 95 | 5341.5 | 4944.6 | 4646.3 |
| 95 - 100 | 5018.1 | 5228.8 | 4893.5 |
| 100 - 105 | 6639.0 | 6144.7 | 5871.3 |
| 105 - 110 | 6107.6 | 6108.0 | 6154.2 |
| 110 - 115 | 6431.9 | 6277.1 | 5868.8 |
| 115 - 120 | 6233.9 | 5104.2 | 4745.9 |
| 120 - 125 | 5734.8 | 5525.1 | 5507.3 |
| 125 - 130 | 5660.8 | 5403.9 | 5006.4 |
| 130 - 135 | 4791.3 | 4590.6 | 4196.1 |
| 135 - 140 | 4090.6 | 4347.0 | 3968.5 |
| 140 - 145 | 3918.7 | 4246.9 | 3836.4 |
| 145 - 150 | 3914.7 | 4257.4 | 3965.8 |
| 150 - 155 | 4342.6 | 4496.0 | 3934.0 |
| 155 - 160 | 5731.7 | 5620.0 | 5559.9 |
| 160 - 165 | 6749.8 | 6628.0 | 6609.7 |
| 165 - 170 | 7765.3 | 7548.1 | 7567.0 |
| 170 - 175 | 6550.5 | 7238.5 | 7068.8 |
| 175 - 180 | 5057.2 | 5433.3 | 5250.1 |
| 180 - 185 | 5008.5 | 4687.6 | 4489.4 |
| 185 - 190 | 4187.5 | 3615.4 | 3226.7 |
| 190 - 195 | 3705.0 | 3801.6 | 3473.7 |

* Velocities recorded photographically at 25-ft standoff

Fragment Velocities
Averaged for Both Firings
Test QD-155-S8A
(Continued)

| Azimuthal Zone (°) | Velocity* (ft/sec) per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 195 - 200 | 4163.5 | 3973.4 | 3625.5 |
| 200 - 205 | 4214.7 | 4306.2 | 2857.1 |
| 205 - 210 | 4350.8 | 4111.6 | 3414.7 |
| 210 - 215 | 4291.0 | 4007.0 | 3689.5 |
| 215 - 220 | 4374.2 | 3355.7 | 4044.9 |
| 220 - 225 | 4408.1 | 4069.3 | 3774.9 |
| 225 - 230 | 4549.2 | 4281.4 | 3600.4 |
| 230 - 235 | 4973.2 | 4738.5 | 4942.8 |
| 235 - 240 | 4832.2 | 5125.2 | 4834.2 |
| 240 - 245 | 5041.9 | 4881.0 | 4879.2 |
| 245 - 250 | 5169.5 | 5088.8 | 4907.3 |
| 250 - 255 | 5296.2 | 5000.3 | 4762.9 |
| 255 - 260 | 4701.8 | 4369.3 | 4606.2 |
| 260 - 265 | 5366.9 | 4412.0 | 5104.2 |
| 265 - 270 | 4734.5 | 4453.5 | 4590.6 |
| 270 - 275 | 4694.9 | 4590.6 | 4589.0 |
| 275 - 280 | 4327.6 | 4566.3 | 4762.1 |
| 280 - 285 | 4456.0 | 4261.5 | 4589.0 |
| 285 - 290 | 4660.7 | 4667.3 | 4551.5 |
| 290 - 295 | 4483.5 | 4985.5 | 4960.9 |
| 295 - 300 | 5091.8 | 5103.7 | 5069.1 |
| 300 - 305 | 5362.0 | 5266.7 | 5319.8 |
| 305 - 310 | 4954.5 | 5319.8 | 5227.0 |
| 310 - 315 | 4668.3 | 4479.5 | 5050.5 |
| 315 - 320 | 4221.3 | 4084.5 | 4593.9 |
| 320 - 325 | 3734.7 | 4160.7 | 3466.1 |
| 325 - 330 | 4097.8 | 4082.5 | 4098.4 |
| 330 - 335 | 3701.4 | 3414.1 | 3816.8 |
| 335 - 340 | 3484.2 | 3560.2 | 3293.7 |
| 340 - 345 | 4004.5 | 3426.1 | 4000.0 |
| 345 - 350 | 4242.2 | 3632.7 | 3270.2 |
| 350 - 355 | 4024.8 | 3628.8 | 3410.9 |
| 355 - 360 | 4323.8 | 3598.3 | 3682.5 |

* Velocities recorded photographically at 25-ft standoff

Fragment Hole Count Data
Firing No. 1
Test QD-155-S8A

| Azimuthal Zone (°) | Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 0 - 5 | 17 | 19 | 26 |
| 5 - 10 | 29 | 37 | 50 |
| 10 - 15 | 58 | 28 | 41 |
| 15 - 20 | 65 | 39 | 41 |
| 20 - 25 | 22 | 32 | 39 |
| 25 - 30 | 25 | 24 | 63 |
| 30 - 35 | 17 | 30 | 65 |
| 35 - 40 | 44 | 20 | 27 |
| 40 - 45 | 11 | 9 | 8 |
| 45 - 50 | 4 | 12 | 8 |
| 50 - 55 | 6 | 11 | 7 |
| 55 - 60 | 7 | 10 | 6 |
| 60 - 65 | 18 | 14 | 18 |
| 65 - 70 | 43 | 32 | 44 |
| 70 - 75 | 82 | 59 | 102 |
| 75 - 80 | 60 | 96 | 97 |
| 80 - 85 | 65 | 52 | 74 |
| 85 - 90 | 40 | 47 | 43 |
| 90 - 95 | 58 | 54 | 66 |
| 95 - 100 | 60 | 91 | 73 |
| 100 - 105 | 102 | 86 | 138 |
| 105 - 110 | 49 | 61 | 77 |
| 110 - 115 | 33 | 42 | 38 |
| 115 - 120 | 39 | 40 | 45 |
| 120 - 125 | 16 | 29 | 46 |
| 125 - 130 | 23 | 48 | 50 |
| 130 - 135 | 20 | 27 | 16 |
| 135 - 140 | 9 | 16 | 12 |
| 140 - 145 | 8 | 15 | 4 |
| 145 - 150 | 4 | 9 | 8 |
| 150 - 155 | 8 | 5 | 8 |
| 155 - 160 | 23 | 29 | 28 |
| 160 - 165 | 63 | 66 | 91 |
| 165 - 170 | 135 | 134 | 167 |
| 170 - 175 | 96 | 103 | 140 |
| 175 - 180 | 32 | 40 | 79 |
| 180 - 185 | 27 | 42 | 31 |
| 185 - 190 | 16 | 10 | 14 |
| 190 - 195 | 5 | 8 | 8 |
| 195 - 200 | 7 | 8 | 10 |
| 200 - 205 | 6 | 15 | 8 |

Fragment Hole Count Data
Firing No. 1
Test QD-155-S8A
(Continued)

| Azimuthal Zone (°) | Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 205 - 210 | 15 | 4 | 7 |
| 210 - 215 | 6 | 10 | 10 |
| 215 - 220 | 9 | 9 | 8 |
| 220 - 225 | 7 | 7 | 6 |
| 225 - 230 | 5 | 13 | 12 |
| 230 - 235 | 33 | 33 | 24 |
| 235 - 240 | 40 | 29 | 56 |
| 240 - 245 | 32 | 36 | 62 |
| 245 - 250 | 48 | 33 | 53 |
| 250 - 255 | 17 | 40 | 57 |
| 255 - 260 | 29 | 40 | 52 |
| 260 - 265 | 31 | 59 | 72 |
| 265 - 270 | 33 | 57 | 54 |
| 270 - 275 | 49 | 46 | 45 |
| 275 - 280 | 37 | 48 | 29 |
| 280 - 285 | 33 | 30 | 19 |
| 285 - 290 | 34 | 24 | 52 |
| 290 - 295 | 33 | 24 | 41 |
| 295 - 300 | 44 | 31 | 35 |
| 300 - 305 | 38 | 33 | 53 |
| 305 - 310 | 24 | 16 | 16 |
| 310 - 315 | 3 | 14 | 6 |
| 315 - 320 | 3 | 4 | 7 |
| 320 - 325 | 5 | 3 | 4 |
| 325 - 330 | 5 | 5 | 3 |
| 330 - 335 | 4 | 12 | 2 |
| 335 - 340 | 5 | 9 | 10 |
| 340 - 345 | 12 | 7 | 9 |
| 345 - 350 | 22 | 14 | 12 |
| 350 - 355 | 31 | 21 | 16 |
| 355 - 360 | 19 | 22 | 30 |

Fragment Hole Count Data
Firing No. 2
Test XD-155-S8A

| Azimuthal Zone (°) | Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 0 - 5 | 23 | 31 | 55 |
| 5 - 10 | 39 | 55 | 56 |
| 10 - 15 | 35 | 56 | 38 |
| 15 - 20 | 36 | 35 | 46 |
| 20 - 25 | 18 | 32 | 41 |
| 25 - 30 | 31 | 36 | 9 |
| 30 - 35 | 9 | 13 | 4 |
| 35 - 40 | 4 | 3 | 4 |
| 40 - 45 | 4 | 5 | 6 |
| 45 - 50 | 4 | 6 | 6 |
| 50 - 55 | 11 | 10 | 10 |
| 55 - 60 | 64 | 51 | 13 |
| 60 - 65 | 53 | 54 | 67 |
| 65 - 70 | 47 | 54 | 105 |
| 70 - 75 | 46 | 39 | 68 |
| 75 - 80 | 41 | 68 | 69 |
| 80 - 85 | 28 | 45 | 45 |
| 85 - 90 | 39 | 29 | 47 |
| 90 - 95 | 84 | 74 | 99 |
| 95 - 100 | 93 | 62 | 116 |
| 100 - 105 | 78 | 54 | 73 |
| 105 - 110 | 47 | 41 | 76 |
| 110 - 115 | 54 | 39 | 73 |
| 115 - 120 | 29 | 50 | 54 |
| 120 - 125 | 50 | 94 | 77 |
| 125 - 130 | 27 | 2[illegible] | 27 |
| 130 - 135 | 5 | 6 | 6 |
| 135 - 140 | 3 | 5 | 11 |
| 140 - 145 | 3 | 4 | 8 |
| 145 - 150 | 4 | 7 | 9 |
| 150 - 155 | 7 | 2 | 6 |
| 155 - 160 | 12 | 27 | 17 |
| 160 - 165 | 83 | 72 | 63 |
| 165 - 170 | 120 | 83 | 166 |
| 170 - 175 | 67 | 62 | 114 |
| 175 - 180 | 37 | 30 | 46 |
| 180 - 185 | 7 | 15 | 11 |
| 185 - 190 | 4 | 12 | 13 |
| 190 - 195 | 8 | 19 | 8 |
| 195 - 200 | 10 | 5 | 6 |
| 200 - 205 | 7 | 11 | 6 |

Fragment Hole Count Data
Firing No. 2
Test QD-155-S8A
(Continued)

| Azimuthal Zone (°) | Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°) 90-95 | 95-100 | 100-105 |
|---|---|---|---|
| 205 - 210 | 3 | 10 | 8 |
| 210 - 215 | 5 | 10 | 11 |
| 215 - 220 | 4 | 4 | 6 |
| 220 - 225 | 8 | 6 | 7 |
| 225 - 230 | 15 | 20 | 25 |
| 230 - 235 | 51 | 47 | 63 |
| 235 - 240 | 31 | 36 | 54 |
| 240 - 245 | 50 | 43 | 83 |
| 245 - 250 | 43 | 57 | 95 |
| 250 - 255 | 40 | 45 | 66 |
| 255 - 260 | 36 | 46 | 32 |
| 260 - 265 | 27 | 49 | 29 |
| 265 - 270 | 32 | 29 | 21 |
| 270 - 275 | 33 | 22 | 26 |
| 275 - 280 | 24 | 36 | 37 |
| 280 - 285 | 30 | 30 | 20 |
| 285 - 290 | 30 | 30 | 20 |
| 290 - 295 | 26 | 21 | 40 |
| 295 - 300 | 79 | 34 | 54 |
| 300 - 305 | 76 | 52 | 42 |
| 305 - 310 | 10 | 17 | 12 |
| 310 - 315 | 13 | 8 | 3 |
| 315 - 320 | 7 | 4 | 6 |
| 320 - 325 | 8 | 9 | 4 |
| 325 - 330 | 4 | 10 | 10 |
| 330 - 335 | 8 | 8 | 3 |
| 335 - 340 | 3 | 5 | 8 |
| 340 - 345 | 13 | 23 | 6 |
| 345 - 350 | 11 | 7 | 10 |
| 350 - 355 | 11 | 20 | 18 |
| 355 - 360 | 14 | 24 | 29 |

FRAGMENT HAZARD INVESTIGATION

Test Number: QD-155-SC4

Item Tested: M107 155-mm projectile, 15-lb TNT

Configuration: Four projectiles vertically positioned, cube configuration, side-by-side, with the projectile centerline parallel and 7 in. apart

Number of Firings/Date: 1/7 November 1977

Location: NSWC/Explosive Experimental Area

Zone Information: Fragment recovery: 75 to 90° Polar
360° Azimuth

Meteorology: 7 November 1977
Barometric Pressure: 29.95 in Hg
Temperature: 72°F

Instrumentation: None

FRAGMENT HAZARD INVESTIGATION

Test Number: QD-155-SC12

Item Tested: M107 155-mm projectile, 15-lb TNT

Configuration: Eight projectiles vertically positioned, two-by-four matrix, side-by-side, with the projectile centerline parallel and 7 in. apart

Number of Firings/Date: 1/20 June 1978

Location: NSWC/Explosive Experimental Area

Zone Information: Fragment recovery: 90 to 105° Polar
180° Azimuth
Fragment hole count: 85 to 105° Polar
180° Azimuth

Meteorology: 20 June 1978
Barometric Pressure: 28.75 in Hg
Temperature: 85°F

Instrumentation: None

Fragment Recovery Data for Azimuthal Zone 90-95°
Test No. QD-155-SC12

| Fragment Wt. (gr) | Polar Zone (°) 60 - 65 No. Fragment | 60 - 65 Total Fragment Wt. (gr) | 65 - 70 No. Fragment | 65 - 70 Total Fragment Wt. (gr) | 70 - 75 No. Fragment | 70 - 75 Total Fragment Wt. (gr) |
|---|---|---|---|---|---|---|
| 0 - 108 | 17 | 352.7 | 12 | 391.2 | 15 | 485.1 |
| 108 - 308 | 1 | 298.8 | 2 | 358.8 | 2 | 420.4 |
| 308 - 500 | 0 | 0.0 | 1 | 357.3 | 0 | 0.0 |
| 500 - 600 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 600 - 700 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 700 - 800 | 0 | 0.0 | 0 | 0.0 | 1 | 746.9 |
| 800 - 900 | 0 | 0.0 | 0 | 0.0 | 1 | 868.6 |
| 900 - 1000 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 1000 - 1200 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 1200 - 1400 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 1400 - 1700 | 0 | 0.0 | 0 | 0 0 | 0 | 0.0 |
| 1700 - 2000 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 2000 - 2500 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 2500 - 3000 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 3000 + | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Totals | 18 | 651.4 | 15 | 1107.3 | 19 | 2521.0 |

Fragment Recovery Data for Azimuthal Zone 90-95°
Test No. QD-155-SC12
(Continued)

| Fragment Wt. (gr) | Polar Zone (°) 75 - 90 No. Fragment | 75 - 90 Total Fragment Wt. (gr) | 90 - 95 No. Fragment | 90 - 95 Total Fragment Wt. (gr) | 95 - 100 No. Fragment | 95 - 100 Total Fragment Wt. (gr) |
|---|---|---|---|---|---|---|
| 0 - 108 | 4 | 110.9 | 44 | 685.3 | 41 | 865.5 |
| 108 - 308 | 1 | 127.8 | 4 | 920.9 | 4 | 639.1 |
| 308 - 500 | 1 | 332.6 | 0 | 0.0 | 1 | 345.0 |
| 500 - 600 | 0 | 0.0 | 0 | 0.0 | 2 | 1084.2 |
| 600 - 700 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 700 - 800 | 0 | 0.0 | 0 | 0.0 | 1 | 774.6 |
| 800 - 900 | 0 | 0.0 | 0 | 0.0 | 1 | 845.5 |
| 900 - 1000 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 1000 - 1200 | 0 | 0.0 | 1 | 1033.3 | 0 | 0.0 |
| 1200 - 1400 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 1400 - 1700 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 1700 - 2000 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 2000 - 2500 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 2500 - 3000 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 3000 + | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Totals | 6 | 571.3 | 49 | 2639.6 | 50 | 4553.8 |

Fragment Recovery Data for Azimuthal Zone 90-95°
Test No. QD-155-SC12
(Continued)

| Fragment Wt. (gr) | Polar Zone (°) 100 - 105 No. Fragment | 100 - 105 Total Fragment Wt. (gr) | 105 - 110 No. Fragment | 105 - 110 Total Fragment Wt. (gr) | 110 - 115 No. Fragment | 110 - 115 Total Fragment Wt. (gr) |
|---|---|---|---|---|---|---|
| 0 - 108 | 51 | 1050.3 | 15 | 274.1 | 11 | 448.1 |
| 108 - 308 | 10 | 1715.6 | 10 | 1837.2 | 3 | 611.4 |
| 308 - 500 | 3 | 1341.3 | 4 | 1606.2 | 0 | 0.0 |
| 500 - 600 | 2 | 1110.3 | 0 | 0.0 | 2 | 1125.7 |
| 600 - 700 | 0 | 0.0 | 1 | 651.4 | 0 | 0.0 |
| 700 - 800 | 0 | 0.0 | 1 | 791.6 | 0 | 0.0 |
| 800 - 900 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 900 - 1000 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 1000 - 1200 | 0 | 0.0 | 1 | 1185.8 | 0 | 0.0 |
| 1200 - 1400 | 0 | 0.0 | 0 | 0.0 | 2 | 2541.0 |
| 1400 - 1700 | 0 | 0.0 | 2 | 3115.4 | 0 | 0.0 |
| 1700 - 2000 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 2000 - 2500 | 1 | 2105.2 | 0 | 0.0 | 0 | 0.0 |
| 2500 - 3000 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 3000 + | 1 | 7760.1 | 0 | 0.0 | 1 | 6361.7 |
| Totals | 68 | 15082.8 | 34 | 9461.8 | 19 | 11088.0 |

Fragment Recovery Data for Azimuthal Zone 90-95°
Test No. QD-155-SC12
(Continued)

| Fragment Wt. (gr) | Polar Zone (°) 115 - 120 No. Fragment | Total Fragment Wt. (gr) |
|---|---|---|
| 0 - 108 | 3 | |
| 0 - 108 | 3 | 83.2 |
| 108 - 308 | 1 | 194.0 |
| 308 - 500 | 1 | 341.9 |
| 500 - 600 | 0 | 0.0 |
| 600 - 700 | 1 | 617.5 |
| 700 - 800 | 0 | 0.0 |
| 800 - 900 | 0 | 0.0 |
| 900 - 1000 | 0 | 0.0 |
| 1000 - 1200 | 0 | 0.0 |
| 1200 - 1400 | 0 | 0.0 |
| 1400 - 1700 | 1 | 1515.8 |
| 1700 - 2000 | 0 | 0.0 |
| 2000 - 2500 | 0 | 0.0 |
| 2500 - 3000 | 0 | 0.0 |
| 3000 + | 0 | 0.0 |
| **Totals** | 7 | 2787.4 |

Fragment Weight and Number Totals Combined for
Polar Zone 60-120° and Azimuthal Zone 90-95°
Test No. QD-155-SC12

| Fragment Wt. (gr) | No. of Fragment | Fragment Wt. (gr) | Average Wt. (gr) |
|---|---|---|---|
| 0 - 108 | 213 | 4746.3 | 22.3 |
| 108 - 308 | 38 | 7124.0 | 187.5 |
| 308 - 500 | 11 | 4324.3 | 393.1 |
| 500 - 600 | 6 | 3320.2 | 553.4 |
| 600 - 700 | 2 | 1269.0 | 634.5 |
| 700 - 800 | 3 | 2313.1 | 771.0 |
| 800 - 900 | 2 | 1714.0 | 857.0 |
| 900 - 1000 | 0 | 0.0 | 0.0 |
| 1000 - 1200 | 2 | 2219.1 | 1109.6 |
| 1200 - 1400 | 2 | 2541.0 | 1270.5 |
| 1400 - 1700 | 3 | 4666.2 | 1555.4 |
| 1700 - 2000 | 0 | 0.0 | 0.0 |
| 2000 - 2500 | 1 | 2105.2 | 2105.2 |
| 2500 - 3000 | 0 | 0.0 | 0.0 |
| 3000 + | 2 | 14121.8 | 7060.9 |

Fragment Number Totals for Azimuthal Zone 75-120°
Test No. QD-155-SC12

| Weight Group (gr) | 60-65 No. Frag. | 65-70 No. Frag. | 70-75 No. Frag. | 90-95 No. Frag. | 95-100 No. Frag. | 100-105 No. Frag. | 105-110 No. Frag. | 110-115 No. Frag. | 115-120 No. Frag. |
|---|---|---|---|---|---|---|---|---|---|
| 0 - 100 | 180 | 201 | 257 | 374 | 499 | 644 | 261 | 184 | 70 |
| 100 - 300 | 30 | 53 | 81 | 38 | 77 | 143 | 117 | 57 | 20 |
| 300 - 500 | 9 | 25 | 37 | 13 | 35 | 64 | 51 | 25 | 11 |
| 500 - 600 | 3 | 12 | 18 | 11 | 24 | 40 | 29 | 17 | 9 |
| 600 - 700 | 3 | 8 | 12 | 8 | 19 | 33 | 25 | 11 | 6 |
| 700 - 800 | 2 | 7 | 9 | 7 | 16 | 29 | 20 | 10 | 3 |
| 800 - 900 | 1 | 3 | 8 | 5 | 14 | 27 | 17 | 9 | 3 |
| 900 - 1000 | 1 | 3 | 3 | 5 | 9 | 23 | 15 | 9 | 3 |
| 1000 - 1200 | 1 | 3 | 3 | 4 | 8 | 18 | 14 | 8 | 2 |
| 1200 - 1400 | 1 | 2 | 3 | 3 | 6 | 13 | 8 | 7 | 2 |
| 1400 - 1700 | 1 | 2 | 2 | 3 | 5 | 12 | 7 | 4 | 2 |
| 1700 - 2000 | 1 | 2 | 2 | 3 | 3 | 7 | 4 | 2 | -* |
| 2000 - 2500 | 1 | 2 | 2 | 2 | 3 | 6 | 4 | 2 | -* |
| 3000+ | - | - | 1 | 1 | 1 | 3 | 2 | 2 | -* |

* No fragments in this weight group

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 90-95°
Polar Zone 60-120°

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 868.60 | 1.00 | 8.1 | 868.6 | 22.4 |
| 746.90 | .80 | 7.5 | 1043.8 | 20.7 |
| 357.30 | .60 | 11.8 | 768.8 | 6.3 |
| 332.60 | .60 | 12.6 | 715.6 | 5.5 |
| 1033.30 | 1.20 | 8.1 | 786.1 | 26.4 |
| 7760.10 | 5.30 | 4.8 | 636.0 | 337.6 |
| 2105.20 | 1.80 | 6.0 | 871.7 | 73.2 |
| 580.60 | 1.20 | 14.5 | 441.7 | 8.3 |
| 529.80 | .90 | 11.9 | 620.5 | 9.3 |
| 489.70 | 1.00 | 14.3 | 489.7 | 7.1 |
| 443.50 | .80 | 12.6 | 619.8 | 7.3 |
| 408.10 | .70 | 12.0 | 696.8 | 7.1 |
| 774.60 | 1.20 | 10.8 | 589.3 | 14.9 |
| 559.00 | .90 | 11.3 | 654.7 | 10.3 |
| 345.00 | .70 | 14.2 | 589.1 | 5.1 |
| 845.60 | 1.00 | 8.3 | 845.6 | 21.2 |
| 525.10 | .90 | 12.0 | 615.0 | 9.1 |
| 1235.10 | 1.40 | 7.9 | 745.6 | 32.4 |
| 1305.90 | 1.30 | 7.0 | 881.0 | 39.0 |
| 6361.70 | 3.80 | 4.2 | 858.8 | 316.5 |
| 526.70 | .90 | 12.0 | 616.9 | 9.2 |
| 599.10 | .90 | 10.5 | 701.7 | 11.9 |
| 318.80 | .70 | 15.4 | 544.3 | 4.3 |
| 677.60 | 1.00 | 10.3 | 677.6 | 13.6 |
| 779.20 | 1.30 | 11.7 | 525.7 | 13.9 |
| 1185.80 | 1.30 | 7.7 | 800.0 | 32.1 |
| 1464.50 | 1.80 | 8.6 | 606.4 | 35.4 |
| 1650.90 | 1.90 | 8.1 | 630.4 | 42.6 |
| 2152.90 | 2.30 | 7.5 | 617.2 | 59.9 |
| 3175.50 | 3.00 | 6.6 | 611.1 | 99.9 |
| 391.10 | .60 | 10.7 | 941.5 | 7.6 |
| 394.20 | .60 | 10.7 | 848.2 | 7.7 |
| 434.30 | .70 | 11.3 | 741.6 | 8.0 |
| 651.40 | 1.20 | 12.9 | 495.5 | 10.5 |
| 791.60 | 1.00 | 8.8 | 791.6 | 18.6 |
| 386.50 | .80 | 14.5 | 540.2 | 5.5 |
| 632.90 | 1.20 | 13.3 | 481.5 | 9.9 |
| 695.10 | 1.00 | 10.1 | 695.1 | 14.4 |
| 1550.80 | 1.40 | 6.3 | 936.2 | 51.0 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 90-95°
Polar Zone 60-120°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 341.90 | .60 | 12.3 | 735.7 | 5.8 |
| 617.50 | .70 | 7.9 | 1054.4 | 16.2 |

Total number of fragments = 41

Average ballistic density for all fragments = 703.2

Average gamma for all fragments = 10.167

Number of hazardous fragments in zone = 5

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 80-100°
Polar Zone 90-100°

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 527.2 | .79 | 10.5 | 746.7 | 10.4 |
| 620.6 | 1.06 | 11.9 | 571.1 | 10.8 |
| 597.3 | 1.02 | 11.9 | 580.7 | 10.4 |
| 1865.5 | 3.48 | 13.0 | 288.0 | 29.8 |
| 821.9 | 1.54 | 13.1 | 429.3 | 13.0 |
| 1027.3 | 1.93 | 13.1 | 383.4 | 16.3 |
| 706.1 | 1.51 | 15.0 | 379.0 | 9.8 |
| 2266.7 | 2.36 | 7.3 | 625.2 | 74.7 |
| 1691.1 | 1.82 | 7.5 | 688.5 | 46.7 |
| 1783.7 | 1.96 | 7.7 | 649.3 | 48.2 |
| 1533.0 | 1.82 | 8.3 | 625.6 | 38.4 |
| 1885.5 | 2.27 | 8.4 | 550.0 | 46.5 |
| 1323.6 | 1.60 | 8.5 | 651.9 | 32.5 |
| 1910.2 | 2.45 | 9.0 | 498.6 | 44.3 |
| 773.4 | 1.12 | 10.2 | 648.6 | 15.8 |
| 521.4 | .79 | 10.6 | 745.1 | 10.2 |
| 511.2 | .80 | 10.9 | 718.9 | 9.7 |
| 2036.8 | 3.31 | 11.4 | 337.8 | 37.2 |
| 913.1 | 1.69 | 12.9 | 417.4 | 14.7 |
| 726.4 | 1.35 | 13.0 | 464.1 | 11.6 |
| 686.2 | 1.30 | 13.3 | 463.5 | 10.8 |
| 863.5 | 1.68 | 13.6 | 395.5 | 13.2 |
| 925.4 | 1.94 | 14.7 | 341.8 | 13.1 |
| 1135.2 | 1.35 | 8.3 | 722.9 | 28.3 |
| 2325.3 | 2.84 | 8.6 | 484.9 | 56.5 |
| 460.0 | .82 | 8.8 | 877.0 | 15.3 |
| 1367.6 | 1.78 | 9.1 | 574.4 | 31.2 |
| 689.9 | .95 | 9.6 | 746.1 | 14.9 |
| 1242.2 | 1.74 | 9.8 | 539.3 | 26.3 |
| 616.8 | .88 | 10.0 | 744.6 | 12.8 |
| 1160.0 | 1.84 | 11.1 | 464.0 | 21.7 |
| 501.1 | .80 | 11.1 | 703.5 | 9.4 |
| 811.3 | 1.31 | 11.3 | 543.6 | 15.0 |
| 1596.4 | 2.59 | 11.4 | 383.3 | 29.3 |
| 2570.6 | 4.19 | 11.4 | 300.0 | 46.9 |
| 565.6 | .98 | 12.1 | 582.6 | 9.7 |
| 578.5 | 1.09 | 13.1 | 511.3 | 9.2 |
| 680.8 | 1.33 | 13.7 | 444.4 | 10.4 |
| 1617.1 | 3.77 | 16.3 | 221.2 | 20.6 |
| 3430.1 | 3.13 | 6.4 | 620.9 | 111.9 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 80-100°
Polar Zone 90-100°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 3450.1 | 3.21 | 6.5 | 599.2 | 110.1 |
| 2356.2 | 2.40 | 7.1 | 634.9 | 68.8 |
| 1277.0 | 1.35 | 7.4 | 812.0 | 35.8 |
| 1007.3 | 1.09 | 7.6 | 886.4 | 27.7 |
| 942.6 | 1.11 | 8.2 | 808.9 | 23.8 |
| 703.7 | .86 | 8.6 | 881.4 | 17.1 |
| 1533.6 | 1.90 | 8.7 | 584.7 | 36.7 |
| 1119.8 | 1.49 | 9.3 | 615.1 | 25.0 |
| 712.0 | .95 | 9.3 | 769.7 | 15.9 |
| 589.2 | .79 | 9.4 | 842.0 | 13.1 |
| 579.2 | .79 | 9.6 | 822.7 | 12.6 |
| 769.3 | 1.07 | 9.8 | 691.1 | 16.4 |
| 815.5 | 1.15 | 9.9 | 663.3 | 17.2 |
| 981.2 | 1.42 | 10.1 | 578.6 | 20.1 |
| 609.0 | .91 | 10.5 | 699.9 | 12.1 |
| 3106.1 | 4.65 | 10.5 | 309.8 | 61.7 |
| 638.8 | .97 | 10.6 | 671.9 | 12.5 |
| 672.0 | 1.02 | 10.7 | 649.2 | 13.1 |
| 669.1 | 1.04 | 10.9 | 630.8 | 12.8 |
| 525.6 | .82 | 11.0 | 703.3 | 10.0 |
| 766.6 | 1.24 | 11.3 | 555.8 | 14.1 |
| 598.5 | .98 | 11.4 | 619.3 | 10.9 |
| 1179.1 | 1.96 | 11.6 | 429.9 | 21.1 |
| 636.2 | 1.11 | 12.2 | 546.2 | 10.9 |
| 590.2 | 1.06 | 12.6 | 540.9 | 9.8 |
| 889.3 | 1.60 | 12.6 | 439.0 | 14.7 |
| 799.5 | 1.44 | 12.6 | 462.6 | 13.2 |
| 747.7 | 1.35 | 12.6 | 478.2 | 12.3 |
| 802.8 | 1.52 | 13.3 | 428.1 | 12.6 |
| 1485.1 | 3.15 | 14.8 | 265.6 | 20.8 |
| 1485.1 | 3.15 | 14.8 | 265.6 | 20.8 |

Total number of fragments = 71

Average ballistic density for all fragments = 571.1

Average gamma for all fragments = 10.75

Number of hazardous fragments in zone = 5

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 75-120°
Polar Zone 90-105°

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 3906.98 | 3.73 | 6.7 | 542.1 | 121.6 |
| 3802.28 | 2.28 | 4.2 | 1108.1 | 188.8 |
| 2450.14 | 2.64 | 7.5 | 572.4 | 67.7 |
| 7279.58 | 5.47 | 5.3 | 569.2 | 287.9 |
| 2638.02 | 3.56 | 9.5 | 392.3 | 58.0 |
| 2758.14 | 3.35 | 8.5 | 450.6 | 67.6 |
| 7760.06 | 5.34 | 4.8 | 628.1 | 334.8 |
| 3243.24 | 3.98 | 8.6 | 407.9 | 78.5 |
| 879.34 | 1.13 | 9.0 | 728.3 | 20.3 |
| 1820.28 | 1.85 | 7.1 | 722.2 | 53.2 |
| 1695.54 | 1.69 | 7.0 | 771.0 | 50.5 |
| 1643.18 | 1.54 | 6.6 | 859.7 | 52.1 |
| 997.92 | 1.06 | 7.4 | 917.8 | 28.0 |
| 1213.52 | 1.44 | 8.3 | 698.9 | 30.3 |
| 563.64 | .94 | 11.7 | 615.6 | 10.0 |
| 512.82 | 1.07 | 14.6 | 461.7 | 7.3 |
| 497.42 | .85 | 12.0 | 630.5 | 8.6 |
| 1074.92 | 1.22 | 8.0 | 794.5 | 28.1 |
| 2105.18 | 1.84 | 6.1 | 842.3 | 71.5 |
| 580.58 | 1.16 | 14.0 | 462.1 | 8.6 |
| 529.76 | .87 | 11.5 | 651.1 | 9.6 |
| 489.72 | .97 | 13.9 | 510.3 | 7.3 |
| 443.52 | .83 | 13.0 | 590.7 | 7.1 |
| 774.62 | 1.22 | 11.0 | 573.5 | 14.6 |
| 559.02 | .89 | 11.1 | 665.4 | 10.4 |
| 344.96 | .69 | 14.0 | 600.1 | 5.1 |
| 1033.34 | 1.16 | 7.8 | 831.5 | 27.4 |
| 651.42 | .85 | 9.1 | 831.4 | 14.8 |
| 539.00 | .87 | 11.3 | 662.5 | 9.9 |
| 478.94 | .76 | 11.1 | 720.2 | 8.9 |
| 397.32 | .63 | 11.0 | 803.3 | 7.5 |
| 386.54 | .62 | 11.2 | 798.1 | 7.2 |
| 346.50 | .66 | 13.4 | 639.7 | 5.4 |
| 1093.40 | 1.11 | 7.1 | 934.3 | 32.0 |
| 418.88 | .81 | 13.5 | 579.1 | 6.5 |
| 392.70 | .80 | 15.0 | 509.6 | 5.5 |
| 311.08 | .68 | 15.4 | 549.2 | 4.2 |
| 882.42 | 1.05 | 8.4 | 816.2 | 22.0 |
| 594.44 | .94 | 11.1 | 648.4 | 11.1 |
| 563.64 | .78 | 9.7 | 821.9 | 12.1 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 75-120°
Polar Zone 90-105°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 314.16 | .62 | 13.8 | 641.4 | 4.7 |
| 434.28 | .80 | 12.9 | 607.5 | 7.0 |
| 423.50 | .74 | 12.3 | 659.3 | 7.2 |
| 392.70 | .73 | 13.0 | 631.8 | 6.3 |
| 620.62 | .92 | 10.4 | 701.1 | 12.4 |
| 383.46 | .66 | 12.1 | 712.9 | 6.6 |
| 2220.68 | 2.32 | 7.3 | 627.8 | 63.1 |
| 1501.50 | 1.84 | 8.6 | 602.9 | 36.5 |
| 1449.14 | 1.74 | 8.4 | 629.0 | 35.8 |
| 851.62 | 1.41 | 11.6 | 507.4 | 15.3 |
| 1002.54 | 1.28 | 8.9 | 696.3 | 23.4 |
| 777.70 | 1.29 | 11.6 | 531.5 | 13.9 |
| 426.58 | .79 | 13.0 | 604.5 | 6.8 |
| 973.28 | 1.17 | 8.4 | 764.7 | 24.0 |
| 888.58 | 1.27 | 10.0 | 618.0 | 18.4 |
| 568.26 | 1.02 | 12.5 | 553.2 | 9.4 |
| 426.58 | .76 | 12.5 | 639.1 | 7.1 |
| 988.68 | 1.17 | 8.3 | 782.1 | 24.8 |
| 380.38 | .66 | 12.1 | 712.7 | 6.5 |
| 355.74 | .60 | 11.9 | 757.9 | 6.2 |
| 308.00 | .57 | 12.9 | 716.4 | 4.9 |
| 321.86 | .60 | 13.1 | 692.4 | 5.1 |
| 408.10 | .74 | 12.7 | 641.2 | 6.7 |
| 845.46 | 1.00 | 8.2 | 850.1 | 21.3 |
| 525.14 | .87 | 11.6 | 647.6 | 9.4 |
| 699.16 | 1.11 | 11.1 | 595.4 | 13.0 |
| 623.70 | .89 | 10.0 | 736.7 | 12.9 |
| 520.52 | .89 | 11.9 | 621.9 | 9.1 |
| 509.74 | .74 | 10.2 | 798.7 | 10.4 |
| 405.02 | .74 | 12.7 | 641.3 | 6.6 |
| 355.74 | .62 | 12.3 | 723.2 | 6.0 |
| 569.80 | .82 | 10.1 | 762.9 | 11.7 |
| 472.78 | .89 | 13.2 | 561.8 | 7.5 |
| 495.86 | .79 | 11.2 | 702.8 | 9.2 |
| 669.90 | .89 | 9.3 | 792.5 | 14.9 |
| 642.18 | .85 | 9.3 | 821.5 | 14.4 |
| 446.60 | .76 | 11.9 | 675.1 | 7.8 |
| 311.08 | .66 | 14.9 | 577.7 | 4.3 |
| 589.82 | .82 | 9.7 | 798.1 | 12.6 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 75-120°
Polar Zone 90-105°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 636.02 | .95 | 10.5 | 682.0 | 12.6 |
| 518.98 | .83 | 11.2 | 682.1 | 9.6 |
| 914.76 | 1.50 | 11.5 | 496.6 | 16.5 |
| 971.74 | 1.24 | 8.9 | 707.6 | 22.7 |
| 793.10 | 1.09 | 9.6 | 694.4 | 17.1 |
| 355.74 | .69 | 13.5 | 626.1 | 5.5 |
| 318.78 | .85 | 18.6 | 407.5 | 3.6 |
| 780.78 | 1.14 | 10.2 | 641.2 | 15.9 |
| 1110.34 | 1.32 | 8.3 | 735.3 | 27.8 |
| 494.34 | .98 | 13.9 | 510.6 | 7.4 |
| 1353.66 | 1.73 | 9.0 | 594.2 | 31.4 |
| 463.54 | .91 | 13.8 | 532.4 | 7.0 |
| 1107.26 | 1.79 | 11.3 | 463.3 | 20.4 |
| 709.94 | 1.32 | 13.0 | 467.7 | 11.3 |
| 1021.02 | 1.29 | 8.9 | 695.3 | 24.0 |
| 930.16 | 1.41 | 10.6 | 553.2 | 18.2 |
| 885.50 | 1.29 | 10.2 | 60.12 | 18.0 |
| 876.26 | 1.70 | 13.6 | 396.4 | 13.4 |
| 1646.26 | 2.47 | 10.5 | 423.2 | 32.6 |
| 1096.48 | 1.56 | 10.0 | 563.2 | 22.9 |
| 694.54 | 1.29 | 13.0 | 475.3 | 11.1 |
| 896.28 | 1.42 | 11.1 | 527.5 | 16.8 |
| 900.90 | 1.43 | 11.1 | 528.4 | 16.9 |
| 2927.54 | 2.69 | 6.4 | 664.1 | 94.7 |
| 1466.08 | 2.01 | 9.6 | 516.4 | 31.9 |
| 2758.14 | 2.62 | 6.7 | 649.5 | 86.2 |
| 1570.80 | 2.13 | 9.5 | 505.5 | 34.4 |
| 1966.58 | 2.19 | 7.8 | 607.9 | 52.5 |
| 859.32 | 1.31 | 10.7 | 572.2 | 16.7 |
| 372.68 | .56 | 10.4 | 900.7 | 7.4 |
| 358.82 | .57 | 11.2 | 828.8 | 6.7 |
| 343.42 | .57 | 11.7 | 789.8 | 6.1 |
| 352.66 | .57 | 11.4 | 812.7 | 6.4 |

Total number of fragments = 112

Average ballistic density for all fragments = 652.7

Average gamma for all fragments = 10.630

Number of hazardous fragments in zone = 12

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 0-180°
Polar Zone 90-105°

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 2602.6 | 2.1 | 5.7 | 851.2 | 95.5 |
| 3049.2 | 2.1 | 4.8 | 1005.6 | 131.9 |
| 2413.2 | 2.3 | 6.7 | 685.4 | 74.8 |
| 3907.0 | 3.7 | 6.7 | 542.1 | 121.6 |
| 3555.9 | 3.0 | 5.9 | 684.3 | 125.2 |
| 3024.6 | 2.0 | 4.7 | 1043.2 | 133.7 |
| 3802.3 | 2.3 | 4.2 | 1108.1 | 188.8 |
| 3200.1 | 3.0 | 6.5 | 618.1 | 101.7 |
| 2450.1 | 2.6 | 7.5 | 572.4 | 67.7 |
| 2126.7 | 2.3 | 7.7 | 593.6 | 57.4 |
| 7279.6 | 5.5 | 5.3 | 569.2 | 287.9 |
| 2638.0 | 3.6 | 9.5 | 392.3 | 58.0 |
| 2758.1 | 3.3 | 8.5 | 450.6 | 67.6 |
| 7760.1 | 5.3 | 4.8 | 628.1 | 334.8 |
| 3243.2 | 4.0 | 8.6 | 407.9 | 78.5 |
| 20745.3 | 14.4 | 4.9 | 378.8 | 886.7 |
| 17911.7 | 11.5 | 4.5 | 459.3 | 829.0 |
| 6588.1 | 12.1 | 12.8 | 156.9 | 106.8 |
| 13974.0 | 7.8 | 3.9 | 637.8 | 741.0 |
| 6435.7 | 6.8 | 7.4 | 365.9 | 182.0 |
| 42088.2 | 24.5 | 4.1 | 347.1 | 2148.4 |
| 7336.6 | 5.4 | 5.1 | 590.5 | 298.2 |
| 3793.0 | 6.1 | 11.3 | 250.9 | 69.9 |
| 44321.2 | 23.1 | 3.6 | 400.3 | 2531.4 |
| 19042.1 | 11.0 | 4.0 | 525.4 | 983.9 |
| 13293.3 | 9.5 | 5.0 | 451.8 | 551.0 |
| 2442.4 | 2.6 | 7.4 | 591.4 | 68.9 |
| 3040.0 | 2.9 | 6.6 | 628.2 | 96.0 |
| 879.3 | 1.1 | 9.0 | 728.3 | 20.3 |
| 1820.3 | 1.9 | 7.1 | 722.2 | 53.2 |
| 1695.5 | 1.7 | 7.0 | 771.0 | 50.5 |
| 1643.2 | 1.5 | 6.6 | 859.7 | 52.1 |
| 997.9 | 1.1 | 7.4 | 917.8 | 28.0 |
| 1213.5 | 1.4 | 8.3 | 698.9 | 30.3 |
| 563.6 | .9 | 11.7 | 615.6 | 10.0 |
| 512.8 | 1.1 | 14.6 | 461.7 | 7.3 |
| 497.4 | .9 | 12.0 | 630.5 | 8.6 |
| 1074.9 | 1.2 | 8.0 | 794.5 | 28.1 |
| 2105.2 | 1.8 | 6.1 | 842.3 | 71.5 |
| 580.6 | 1.2 | 14.0 | 462.1 | 8.6 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 0-180°
Polar Zone 90-105°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 529.8 | .9 | 11.5 | 651.1 | 9.6 |
| 489.7 | 1.0 | 13.9 | 510.3 | 7.3 |
| 443.5 | .8 | 13.0 | 590.7 | 7.1 |
| 774.6 | 1.2 | 11.0 | 573.5 | 14.6 |
| 559.0 | .9 | 11.1 | 665.4 | 10.4 |
| 345.0 | .7 | 14.0 | 600.1 | 5.1 |
| 1033.3 | 1.2 | 7.8 | 831.5 | 27.4 |
| 572.9 | .9 | 11.2 | 655.1 | 10.7 |
| 309.5 | .6 | 14.2 | 621.7 | 4.5 |
| 651.4 | .8 | 9.1 | 831.4 | 14.8 |
| 539.0 | .9 | 11.3 | 662.5 | 9.9 |
| 478.9 | .8 | 11.1 | 720.2 | 8.9 |
| 397.3 | .6 | 11.0 | 803.3 | 7.5 |
| 386.5 | .6 | 11.2 | 798.1 | 7.2 |
| 346.5 | .7 | 13.4 | 639.7 | 5.4 |
| 1093.4 | 1.1 | 7.1 | 934.3 | 32.0 |
| 418.9 | .8 | 13.5 | 579.1 | 6.5 |
| 392.7 | .8 | 15.0 | 509.6 | 5.5 |
| 311.1 | .7 | 15.4 | 549.2 | 4.2 |
| 882.4 | 1.1 | 8.4 | 816.2 | 22.0 |
| 594.4 | .9 | 11.1 | 648.4 | 11.1 |
| 563.6 | .8 | 9.7 | 821.9 | 12.1 |
| 314.2 | .6 | 13.8 | 641.4 | 4.7 |
| 434.3 | .8 | 12.9 | 607.5 | 7.0 |
| 423.5 | .7 | 12.3 | 659.3 | 7.2 |
| 392.7 | .7 | 13.0 | 631.8 | 6.3 |
| 620.6 | .9 | 10.4 | 701.1 | 12.4 |
| 383.5 | .7 | 12.1 | 712.9 | 6.6 |
| 2220.7 | 2.3 | 7.3 | 627.8 | 63.1 |
| 1501.5 | 1.8 | 8.6 | 602.9 | 36.5 |
| 1449.1 | 1.7 | 8.4 | 629.0 | 35.8 |
| 851.6 | 1.4 | 11.6 | 507.4 | 15.3 |
| 742.3 | 1.1 | 10.3 | 652.3 | 15.0 |
| 1047.2 | 1.3 | 8.4 | 746.8 | 26.0 |
| 1233.5 | 1.2 | 6.5 | 996.7 | 39.2 |
| 890.1 | 1.1 | 9.0 | 724.8 | 20.5 |
| 542.1 | 1.0 | 13.3 | 520.3 | 8.5 |
| 494.3 | 1.0 | 13.9 | 509.3 | 7.4 |
| 366.5 | .9 | 16.7 | 448.8 | 4.6 |
| 11.1 | .7 | 16.7 | 486.9 | 3.9 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 0-180°
Polar Zone 90-105°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 1002.5 | 1.3 | 8.9 | 696.3 | 23.4 |
| 777.7 | 1.3 | 11.6 | 531.5 | 13.9 |
| 426.6 | .8 | 13.0 | 604.5 | 6.8 |
| 973.3 | 1.2 | 8.4 | 764.7 | 24.0 |
| 888.6 | 1.3 | 10.0 | 618.0 | 18.4 |
| 568.3 | 1.0 | 12.5 | 553.2 | 9.4 |
| 426.6 | .8 | 12.5 | 639.1 | 7.1 |
| 988.7 | 1.2 | 8.3 | 782.1 | 24.8 |
| 380.4 | .7 | 12.1 | 712.7 | 6.5 |
| 355.7 | .6 | 11.9 | 757.9 | 6.2 |
| 308.0 | .6 | 12.9 | 716.4 | 4.9 |
| 321.9 | .6 | 13.1 | 692.4 | 5.1 |
| 408.1 | .7 | 12.7 | 641.2 | 6.7 |
| 845.5 | 1.0 | 8.2 | 850.1 | 21.3 |
| 525.1 | .9 | 11.6 | 647.6 | 9.4 |
| 474.3 | .8 | 11.4 | 696.2 | 8.6 |
| 471.[illegible] | .8 | 12.5 | 612.3 | 7.9 |
| 363.4 | .9 | 16.4 | 461.3 | 4.6 |
| 622.2 | 1.0 | 10.9 | 649.9 | 11.8 |
| 820.8 | .[illegible] | 7.6 | 983.5 | 22.6 |
| 341.9 | .8 | 16.8 | 460.7 | 4.2 |
| 583.7 | 1.0 | 12.0 | 582.8 | 10.1 |
| 388.1 | .8 | 13.8 | 582.5 | 5.9 |
| 537.5 | 1.1 | 14.6 | 451.2 | 7.6 |
| 375.8 | .8 | 14.1 | 571.9 | 5.[illegible] |
| 446.6 | .[illegible] | 14.0 | 527.5 | 5.6 |
| 335.7 | .8 | 16.3 | 485.9 | 4.3 |
| 525.1 | 1.1 | 15.2 | 432.5 | 7.2 |
| 360.4 | .7 | 12.7 | 683.4 | 5.9 |
| 340.3 | .7 | 15.3 | 531.9 | 4.[illegible] |
| 318.8 | .6 | 13.8 | 642.8 | 4.8 |
| 392.7 | .8 | 14.9 | 515.4 | 5.5 |
| 602.1 | .9 | 10.[illegible] | 732.3 | 12.3 |
| 331.1 | .7 | 13.9 | 620.3 | 5.0 |
| 329.6 | .6 | 12.4 | 739.7 | 5.[illegible] |
| 768.5 | 1.[illegible] | 8.9 | 798.5 | 18.[illegible] |
| 525.1 | .9 | 12.3 | 593.1 | 8.9 |
| 429.7 | 8 | 12.5 | 636.3 | 7.1 |
| 409.6 | .7 | 12.5 | 651.6 | 6.[illegible] |
| 369.6 | .6 | 11.7 | 758.6 | 6.6 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 0-180°
Polar Zone 90-105°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 377.3 | .7 | 13.1 | 635.9 | 6.0 |
| 311.1 | .6 | 14.2 | 619.7 | 4.6 |
| 539.0 | .8 | 9.8 | 827.4 | 11.5 |
| 614.5 | 1.1 | 12.1 | 562.2 | 10.6 |
| 1538.5 | 1.7 | 7.6 | 708.3 | 41.9 |
| 696.1 | 1.1 | 11.3 | 582.0 | 12.8 |
| 893.2 | 1.6 | 12.6 | 437.8 | 14.7 |
| 616.0 | 1.0 | 11.2 | 633.4 | 11.5 |
| 580.6 | 1.0 | 12.3 | 561.3 | 9.8 |
| 352.7 | .9 | 17.7 | 419.3 | 4.1 |
| 623.7 | 1.4 | 15.7 | 375.9 | 8.2 |
| 705.3 | 1.3 | 12.5 | 496.0 | 11.7 |
| 632.9 | 1.0 | 11.0 | 638.8 | 12.0 |
| 976.4 | 1.4 | 10.3 | 563.3 | 19.6 |
| 974.8 | 1.4 | 10.1 | 580.6 | 20.0 |
| 871.6 | 1.1 | 8.7 | 773.2 | 20.8 |
| 314.2 | .8 | 17.8 | 440.2 | 3.7 |
| 591.4 | 1.0 | 11.4 | 626.6 | 10.8 |
| 843.9 | 1.2 | 10.2 | 621.8 | 17.3 |
| 1110.3 | 1.3 | 7.9 | 789.9 | 29.2 |
| 592.9 | 1.1 | 12.9 | 521.7 | 9.6 |
| 417.3 | 1.0 | 16.5 | 429.6 | 5.3 |
| 785.4 | 1.3 | 11.2 | 560.8 | 14.6 |
| 366.5 | .9 | 16.3 | 465.7 | 4.7 |
| 751.5 | 1.3 | 12.0 | 515.7 | 13.1 |
| 529.8 | 1.0 | 12.8 | 558.7 | 8.6 |
| 702.2 | 1.2 | 11.6 | 556.1 | 12.5 |
| 699.2 | 1.1 | 11.1 | 595.4 | 13.0 |
| 623.7 | .9 | 10.0 | 736.7 | 12.9 |
| 520.5 | .9 | 11.9 | 621.9 | 9.1 |
| 509.7 | .7 | 10.2 | 798.7 | 10.4 |
| 405.0 | .7 | 12.7 | 641.3 | 6.6 |
| 355.7 | .6 | 12.3 | 723.2 | 6.0 |
| 569.8 | .8 | 10.1 | 762.9 | 11.7 |
| 472.8 | .9 | 13.2 | 561.8 | 7.5 |
| 495.9 | .8 | 11.2 | 702.8 | 9.2 |
| 669.9 | .9 | 9.3 | 792.5 | 14.9 |
| 642.2 | .8 | 9.3 | 821.5 | 14.4 |
| 446.6 | .8 | 11.9 | 675.1 | 7.8 |
| 311.1 | .7 | 14.9 | 577.7 | 4.3 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 0-180°
Polar Zone 90-105°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 589.8 | .8 | 9.7 | 798.1 | 12.6 |
| 636.0 | 1.0 | 10.5 | 682.0 | 12.6 |
| 519.0 | .8 | 11.2 | 682.1 | 9.6 |
| 914.8 | 1.5 | 11.5 | 496.6 | 16.5 |
| 1852.6 | 2.1 | 8.1 | 595.3 | 47.8 |
| 1720.2 | 2.0 | 8.3 | 595.8 | 43.4 |
| 2148.3 | 2.5 | 8.0 | 555.5 | 55.7 |
| 557.5 | 1.4 | 17.2 | 347.7 | 6.7 |
| 1278.2 | 1.8 | 9.9 | 524.4 | 26.8 |
| 823.9 | 1.5 | 12.8 | 446.0 | 13.4 |
| 1751.0 | 2.3 | 9.1 | 507.1 | 39.9 |
| 1025.6 | 1.9 | 12.7 | 404.6 | 16.8 |
| 2097.5 | 1.9 | 6.5 | 779.5 | 67.6 |
| 971.7 | 1.2 | 8.9 | 707.6 | 22.7 |
| 793.1 | 1.1 | 9.6 | 694.4 | 17.1 |
| 355.7 | .7 | 13.5 | 626.1 | 5.5 |
| 318.8 | .8 | 18.6 | 407.5 | 3.6 |
| 780.8 | 1.1 | 10.2 | 641.2 | 15.9 |
| 1110.3 | 1.3 | 8.3 | 735.3 | 27.8 |
| 494.3 | 1.0 | 13.9 | 510.6 | 7.4 |
| 1353.7 | 1.7 | 9.0 | 594.2 | 31.4 |
| 463.5 | .9 | 13.8 | 532.4 | 7.0 |
| 1107.3 | 1.8 | 11.3 | 463.3 | 20.4 |
| 709.9 | 1.3 | 13.0 | 467.7 | 11.3 |
| 1021.0 | 1.3 | 8.9 | 695.3 | 24.0 |
| 463.5 | .9 | 13.4 | 557.3 | 7.2 |
| 309.5 | .8 | 19.2 | 396.9 | 3.4 |
| 1054.9 | 1.3 | 8.7 | 705.2 | 25.3 |
| 1208.9 | 1.7 | 9.6 | 566.7 | 26.2 |
| 1044.1 | 1.6 | 10.9 | 505.2 | 20.0 |
| 611.4 | 1.2 | 13.2 | 492.3 | 9.6 |
| 817.7 | 1.2 | 10.4 | 612.0 | 16.4 |
| 486.6 | .9 | 13.3 | 545.7 | 7.6 |
| 1587.7 | 1.8 | 7.9 | 662.5 | 41.8 |
| 1061.1 | 1.6 | 10.5 | 528.4 | 21.0 |
| 328.0 | .8 | 16.7 | 472.6 | 4.1 |
| 569.8 | 1.1 | 13.5 | 495.8 | 8.8 |
| 771.5 | 1.2 | 11.0 | 574.1 | 14.5 |
| 825.4 | 1.2 | 10.2 | 628.4 | 16.9 |
| 625.2 | 1.0 | 11.5 | 603.4 | 11.3 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 0-180°
Polar Zone 90-105°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 494.3 | 1.0 | 13.7 | 518.3 | 7.5 |
| 381.9 | .8 | 13.9 | 575.2 | 5.7 |
| 967.1 | 1.3 | 9.3 | 659.7 | 21.5 |
| 1208.9 | 1.4 | 8.1 | 728.8 | 31.0 |
| 1264.3 | 1.5 | 8.4 | 676.4 | 31.3 |
| 1090.3 | 1.4 | 9.1 | 648.7 | 25.0 |
| 1252.0 | 1.5 | 8.7 | 649.9 | 30.1 |
| 673.0 | 1.0 | 10.6 | 655.3 | 13.2 |
| 1971.2 | 2.6 | 9.1 | 477.2 | 44.8 |
| 2453.2 | 3.1 | 8.8 | 452.5 | 57.9 |
| 1690.9 | 2.5 | 10.3 | 428.1 | 34.0 |
| 1878.8 | 2.7 | 10.0 | 425.9 | 39.0 |
| 930.2 | 1.4 | 10.6 | 553.2 | 18.2 |
| 885.5 | 1.3 | 10.2 | 601.2 | 18.0 |
| 876.3 | 1.7 | 13.6 | 396.4 | 13.4 |
| 1646.3 | 2.5 | 10.5 | 423.2 | 32.6 |
| 1096.5 | 1.6 | 10.0 | 563.2 | 22.9 |
| 457.4 | 1.4 | 21.0 | 285.2 | 4.5 |
| 1960.4 | 1.9 | 6.9 | 733.0 | 59.3 |
| 694.5 | 1.3 | 13.0 | 475.3 | 11.1 |
| 896.3 | 1.4 | 11.1 | 527.5 | 16.8 |
| 900.9 | 1.4 | 11.1 | 528.4 | 16.9 |
| 608.3 | 1.2 | 13.3 | 487.7 | 9.5 |
| 557.5 | 1.3 | 16.1 | 384.3 | 7.2 |
| 1252.0 | 1.5 | 8.2 | 703.3 | 31.7 |
| 1093.4 | 1.4 | 9.3 | 627.4 | 24.5 |
| 1552.3 | 2.0 | 9.1 | 542.8 | 35.5 |
| 1566.2 | 2.3 | 10.2 | 455.1 | 32.0 |
| 1570.8 | 2.2 | 9.9 | 474.4 | 33.0 |
| 1165.8 | 2.0 | 12.3 | 397.7 | 19.7 |
| 777.7 | 1.1 | 9.5 | 722.7 | 17.1 |
| 1004.1 | 1.8 | 12.9 | 399.7 | 16.2 |
| 1663.2 | 2.2 | 9.2 | 515.4 | 37.6 |
| 2927.5 | 2.7 | 6.4 | 664.1 | 94.7 |
| 1466.1 | 2.0 | 9.6 | 516.4 | 31.9 |
| 2071.3 | 2.4 | 8.2 | 548.8 | 52.6 |
| 1062.6 | 1.7 | 11.3 | 471.5 | 19.5 |
| 2758.1 | 2.6 | 6.7 | 649.5 | 86.2 |
| 1570.8 | 2.1 | 9.5 | 505.5 | 34.4 |
| 1966.6 | 2.2 | 7.8 | 607.9 | 52.5 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 0-180°
Polar Zone 90-105°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 908.6 | 1.4 | 10.4 | 576.6 | 18.1 |
| 859.3 | 1.3 | 10.7 | 572.2 | 16.7 |
| 432.7 | .6 | 10.3 | 850.7 | 8.7 |
| 401.9 | .8 | 13.1 | 617.3 | 6.4 |
| 616.0 | .8 | 8.6 | 928.8 | 14.8 |
| 506.7 | .8 | 11.5 | 670.1 | 9.2 |
| 381.9 | .8 | 14.2 | 559.9 | 5.6 |
| 374.2 | .7 | 12.4 | 697.2 | 6.3 |
| 320.3 | .7 | 15.9 | 518.1 | 4.2 |
| 511.3 | .9 | 12.9 | 557.2 | 8.2 |
| 349.6 | .6 | 12.5 | 708.8 | 5.8 |
| 509.7 | .9 | 12.3 | 601.7 | 8.6 |
| 438.9 | .9 | 14.5 | 508.5 | 6.3 |
| 337.3 | .6 | 13.1 | 672.2 | 5.4 |
| 329.6 | .5 | 10.5 | 942.1 | 6.5 |
| 372.7 | .6 | 10.4 | 900.7 | 7.4 |
| 358.8 | .6 | 11.2 | 828.8 | 6.7 |
| 343.4 | .6 | 11.7 | 789.8 | 6.1 |
| 352.7 | .6 | 11.4 | 812.7 | 6.4 |
| 378.8 | .6 | 11.4 | 784.1 | 6.9 |
| 317.2 | .5 | 11.7 | 821.4 | 5.6 |
| 311.1 | .5 | 10.8 | 931.0 | 6.0 |
| 1897.3 | 2.2 | 8.1 | 587.2 | 48.9 |
| 947.1 | 1.8 | 13.5 | 384.4 | 14.6 |
| 1014.9 | 1.5 | 10.1 | 575.2 | 21.0 |
| 699.2 | 1.3 | 12.7 | 486.8 | 11.4 |
| 1526.1 | 1.9 | 8.7 | 581.0 | 36.4 |
| 1609.3 | 1.9 | 8.2 | 619.4 | 40.7 |
| 850.1 | 1.2 | 9.8 | 650.7 | 18.0 |
| 696.1 | 1.0 | 10.2 | 676.6 | 14.1 |
| 1131.9 | 1.3 | 7.9 | 783.1 | 29.8 |
| 862.4 | 1.1 | 9.1 | 727.4 | 19.7 |
| 629.9 | 1.1 | 11.9 | 567.8 | 11.0 |
| 612.9 | 1.0 | 11.6 | 595.0 | 10.9 |
| 442.0 | .8 | 12.8 | 609.0 | 7.2 |
| 452.8 | 1.0 | 14.8 | 485.3 | 6.4 |
| 847.0 | 1.1 | 9.2 | 725.8 | 19.2 |
| 1068.8 | 1.4 | 9.0 | 665.5 | 24.8 |
| 352.7 | .8 | 16.1 | 482.6 | 4.6 |
| 332.6 | .7 | 15.0 | 551.2 | 4.6 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 0-180°
Polar Zone 90-105°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 1054.9 | 1.3 | 8.4 | 742.6 | 26.2 |
| 495.9 | .9 | 12.2 | 617.3 | 8.5 |
| 1162.7 | 1.3 | 8.1 | 749.5 | 30.0 |
| 1586.2 | 1.8 | 7.8 | 678.8 | 42.5 |
| 1553.9 | 2.5 | 11.1 | 400.1 | 29.0 |
| 1980.4 | 2.1 | 7.3 | 670.5 | 56.6 |
| 1350.6 | 1.7 | 8.9 | 596.1 | 31.4 |
| 1957.3 | 2.2 | 7.8 | 612.4 | 52.5 |
| 619.1 | .9 | 9.9 | 757.0 | 13.0 |
| 546.7 | .9 | 12.1 | 597.7 | 9.4 |
| 369.6 | .7 | 13.2 | 634.5 | 5.8 |
| 800.8 | 1.0 | 8.9 | 780.1 | 18.7 |
| 332.6 | .6 | 12.5 | 726.2 | 5.5 |
| 813.1 | 1.0 | 8.9 | 776.1 | 19.0 |
| 555.9 | 1.0 | 12.3 | 576.7 | 9.4 |
| 392.7 | .8 | 13.4 | 602.9 | 6.1 |
| 502.0 | .7 | 10.0 | 823.0 | 10.4 |
| 397.3 | .7 | 11.6 | 739.1 | 7.1 |
| 871.6 | 1.0 | 8.3 | 830.5 | 21.9 |
| 405.0 | .7 | 12.0 | 696.1 | 7.0 |
| 354.2 | .6 | 12.6 | 698.9 | 5.9 |
| 526.7 | 1.0 | 12.8 | 556.2 | 8.5 |
| 366.5 | .7 | 13.2 | 637.3 | 5.8 |
| 463.5 | .7 | 10.6 | 791.7 | 9.1 |
| 408.1 | .8 | 13.3 | 595.0 | 6.4 |
| 314.2 | .7 | 14.6 | 595.2 | 4.5 |
| 361.9 | .6 | 12.4 | 705.7 | 6.1 |
| 317.2 | .7 | 15.1 | 561.2 | 4.4 |
| 651.4 | .9 | 9.2 | 823.3 | 14.7 |
| 711.5 | .9 | 9.3 | 772.9 | 15.9 |
| 381.9 | .7 | 11.9 | 726.2 | 6.7 |
| 803.9 | 1.1 | 9.6 | 699.0 | 17.5 |
| 360.4 | .7 | 13.1 | 654.0 | 5.7 |
| 811.6 | 1.0 | 8.7 | 800.3 | 19.4 |
| 780.8 | 1.0 | 9.1 | 765.3 | 17.9 |
| 328.0 | .5 | 11.7 | 811.3 | 5.8 |

Total number of fragments = 316

Average ballistic density for all fragments = 623.0

Average gamma for all fragments = 10.909

Number of hazardous fragments in zone = 33

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 0-180°
Polar Zone 105-120°

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 369.6 | .7 | 13.8 | 595.1 | 5.6 |
| 465.1 | .7 | 10.2 | 835.0 | 9.5 |
| 569.8 | .7 | 8.5 | 989.2 | 13.9 |
| 699.2 | 1.0 | 10.5 | 653.3 | 13.9 |
| 448.1 | .6 | 10.1 | 865.2 | 9.3 |
| 614.5 | .9 | 9.7 | 778.7 | 13.1 |
| 318.8 | .5 | 11.1 | 892.0 | 6.0 |
| 324.9 | .5 | 11.6 | 826.5 | 5.8 |
| 452.8 | .7 | 11.0 | 755.2 | 8.6 |
| 458.9 | .7 | 11.3 | 715.6 | 8.4 |
| 489.7 | .8 | 10.9 | 737.9 | 9.4 |
| 345.0 | .6 | 12.0 | 756.5 | 6.0 |
| 383.5 | .7 | 12.9 | 649.1 | 6.2 |
| 526.7 | .8 | 10.3 | 776.1 | 10.7 |
| 653.0 | .9 | 9.2 | 822.3 | 14.8 |
| 454.3 | .7 | 10.9 | 758.8 | 8.6 |
| 522.1 | .7 | 9.9 | 818.0 | 10.9 |
| 974.8 | 1.0 | 7.4 | 931.7 | 27.4 |
| 309.5 | .6 | 13.0 | 710.1 | 5.0 |
| 323.4 | .6 | 12.1 | 778.3 | 5.6 |
| 371.1 | .7 | 12.7 | 667.9 | 6.1 |
| 440.4 | .8 | 12.3 | 647.3 | 7.5 |
| 617.5 | .9 | 9.9 | 760.3 | 13.0 |
| 1044.1 | 1.3 | 8.9 | 681.4 | 24.4 |
| 531.3 | .7 | 9.9 | 821.4 | 11.2 |
| 548.2 | .8 | 9.8 | 812.5 | 11.6 |
| 318.8 | .6 | 14.1 | 620.5 | 4.7 |
| 358.8 | .5 | 10.6 | 902.0 | 7.1 |
| 519.0 | .7 | 10.0 | 813.4 | 10.8 |
| 754.4 | 1.0 | 9.8 | 694.5 | 15.7 |
| 617.5 | .9 | 10.3 | 710.2 | 12.4 |
| 391.2 | .6 | 11.2 | 791.4 | 7.3 |
| 394.2 | .6 | 10.7 | 846.5 | 7.7 |
| 434.3 | .7 | 11.7 | 703.7 | 7.7 |
| 651.4 | 1.2 | 12.4 | 522.4 | 10.9 |
| 791.6 | 1.0 | 9.2 | 750.4 | 18.0 |
| 526.7 | .9 | 12.5 | 576.3 | 8.8 |
| 599.1 | .9 | 10.1 | 750.1 | 12.4 |
| 341.9 | .6 | 11.7 | 795.8 | 6.1 |
| 617.5 | .7 | 8.3 | 980.8 | 15.4 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 0-180°
Polar Zone 105-120°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 318.8 | .6 | 12.4 | 751.1 | 5.3 |
| 443.5 | .7 | 10.5 | 812.9 | 8.8 |
| 372.7 | .8 | 14.6 | 543.7 | 5.3 |
| 338.8 | .5 | 10.5 | 940.9 | 6.7 |
| 563.6 | .8 | 9.5 | 845.7 | 12.4 |
| 1041.0 | 1.3 | 8.5 | 738.9 | 25.6 |
| 237.2 | .5 | 14.5 | 687.5 | 3.4 |
| 537.5 | .8 | 11.0 | 689.1 | 10.1 |
| 385.0 | .6 | 11.1 | 803.3 | 7.2 |
| 420.4 | .7 | 11.8 | 703.7 | 7.4 |
| 475.9 | .8 | 11.9 | 655.4 | 8.3 |
| 485.1 | .9 | 13.2 | 557.3 | 7.7 |
| 512.8 | .8 | 11.2 | 687.7 | 9.5 |
| 323.4 | .5 | 11.6 | 820.6 | 5.8 |
| 338.8 | .6 | 12.9 | 688.6 | 5.5 |
| 455.8 | .8 | 11.7 | 688.7 | 8.1 |
| 783.9 | 1.0 | 9.1 | 766.5 | 18.0 |
| 317.2 | .5 | 10.8 | 931.6 | 6.1 |
| 440.4 | .7 | 10.9 | 774.2 | 8.4 |
| 465.1 | .7 | 10.7 | 773.6 | 9.0 |
| 352.7 | .7 | 13.3 | 642.6 | 5.5 |
| 365.0 | .7 | 13.5 | 621.0 | 5.6 |
| 389.6 | .6 | 11.4 | 774.4 | 7.1 |
| 400.4 | .7 | 11.5 | 746.0 | 7.2 |
| 405.0 | .7 | 12.9 | 628.2 | 6.5 |
| 438.9 | .8 | 12.6 | 627.8 | 7.3 |
| 443.5 | .6 | 9.4 | 967.1 | 9.8 |
| 591.4 | .9 | 10.1 | 750.9 | 12.2 |
| 597.5 | .8 | 9.9 | 765.4 | 12.5 |
| 318.8 | .7 | 14.8 | 577.7 | 4.5 |
| 677.6 | 1.0 | 10.6 | 654.7 | 13.3 |
| 309.5 | .7 | 15.2 | 562.1 | 4.2 |
| 349.6 | .7 | 14.8 | 552.2 | 4.9 |
| 372.7 | .7 | 12.7 | 668.0 | 6.1 |
| 392.7 | .7 | 13.3 | 606.5 | 6.1 |
| 397.3 | .7 | 11.8 | 723.8 | 7.0 |
| 432.7 | .7 | 10.7 | 805.6 | 8.4 |
| 505.1 | .9 | 12.4 | 596.8 | 8.5 |
| 514.4 | .9 | 12.9 | 559.9 | 8.3 |
| 582.1 | .7 | 8.4 | 990.4 | 14.4 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 0-180°
Polar Zone 105-120°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 312.6 | .7 | 16.4 | 497.3 | 4.0 |
| 338.8 | .7 | 13.5 | 644.4 | 5.2 |
| 343.4 | .7 | 14.3 | 582.3 | 5.0 |
| 514.4 | .7 | 10.0 | 811.0 | 10.6 |
| 489.7 | 1.0 | 14.0 | 503.9 | 7.3 |
| 522.1 | 1.0 | 13.0 | 548.4 | 8.4 |
| 528.2 | 1.0 | 12.9 | 549.4 | 8.5 |
| 489.7 | .9 | 12.8 | 580.5 | 8.0 |
| 991.8 | 1.3 | 9.2 | 664.8 | 22.4 |
| 687.9 | 1.1 | 10.0 | 657.1 | 16.3 |
| 386.5 | .8 | 14.5 | 537.7 | 5.5 |
| 676.1 | 1.1 | 11.0 | 616.6 | 12.8 |
| 1054.9 | 1.3 | 8.6 | 720.7 | 25.6 |
| 1033.3 | 1.2 | 8.3 | 762.0 | 25.9 |
| 1008.7 | 1.3 | 9.1 | 667.6 | 23.0 |
| 189.4 | 1.4 | 52.2 | 112.8 | .8 |
| 813.1 | 1.3 | 11.4 | 533.9 | 14.8 |
| 956.3 | 1.3 | 9.5 | 647.1 | 20.9 |
| 415.8 | .7 | 12.5 | 649.3 | 6.9 |
| 417.3 | .7 | 11.2 | 761.4 | 7.7 |
| 805.5 | 1.0 | 9.0 | 760.8 | 18.7 |
| 392.7 | .9 | 15.6 | 479.4 | 5.2 |
| 962.5 | 1.2 | 9.1 | 690.2 | 22.1 |
| 1001.0 | 1.2 | 8.6 | 731.4 | 24.2 |
| 632.9 | 1.2 | 13.3 | 482.1 | 9.9 |
| 696.1 | 1.0 | 10.3 | 669.4 | 14.0 |
| 779.2 | 1.3 | 11.9 | 513.2 | 13.7 |
| 559.0 | 1.0 | 12.5 | 561.3 | 9.3 |
| 592.9 | 1.0 | 11.6 | 607.5 | 10.6 |
| 928.6 | 1.2 | 9.1 | 699.1 | 21.2 |
| 1064.1 | 1.4 | 9.3 | 631.7 | 23.8 |
| 705.3 | 1.2 | 11.5 | 564.6 | 12.7 |
| 930.2 | 1.3 | 10.0 | 603.2 | 19.3 |
| 480.5 | 1.0 | 14.1 | 504.4 | 7.1 |
| 743.8 | 1.1 | 10.0 | 675.4 | 15.4 |
| 1252.0 | 1.5 | 8.2 | 710.9 | 31.9 |
| 1635.5 | 1.4 | 6.0 | 978.6 | 56.4 |
| 1523.1 | 1.9 | 8.7 | 585.4 | 36.4 |
| 2601.1 | 2.0 | 5.4 | 919.6 | 100.5 |
| 6976.2 | 4.3 | 4.3 | 796.2 | 340.3 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 0-180°
Polar Zone 105-120°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 7007.0 | 3.8 | 3.8 | 933.6 | 380.6 |
| 5106.6 | 3.4 | 4.6 | 832.9 | 231.3 |
| 1185.8 | 1.3 | 7.7 | 800.0 | 32.1 |
| 1464.5 | 1.8 | 8.5 | 619.3 | 35.9 |
| 1650.9 | 1.9 | 7.8 | 656.1 | 43.8 |
| 1235.1 | 1.4 | 7.7 | 773.0 | 33.2 |
| 1305.9 | 1.3 | 6.9 | 898.3 | 39.5 |
| 6361.7 | 3.8 | 4.1 | 870.2 | 319.3 |
| 1550.8 | 1.4 | 6.5 | 895.9 | 49.6 |
| 1341.3 | 1.6 | 8.2 | 678.6 | 33.9 |
| 1464.5 | 1.8 | 8.4 | 632.6 | 36.4 |
| 1524.6 | 1.9 | 8.8 | 578.3 | 36.2 |
| 1734.0 | 2.1 | 8.5 | 569.8 | 42.5 |
| 2216.1 | 2.0 | 6.3 | 783.5 | 73.0 |
| 2899.8 | 2.2 | 5.3 | 893.7 | 114.0 |
| 3124.7 | 2.5 | 5.5 | 802.5 | 117.2 |
| 1538.5 | 1.8 | 8.0 | 655.2 | 39.8 |
| 2189.9 | 2.1 | 6.7 | 723.9 | 68.1 |
| 3635.9 | 2.6 | 5.0 | 875.7 | 152.1 |
| 2328.5 | 2.1 | 6.4 | 751.7 | 75.8 |
| 2152.9 | 2.3 | 7.5 | 610.6 | 59.5 |
| 3175.5 | 3.0 | 6.7 | 603.6 | 99.1 |
| 6292.4 | 3.4 | 3.8 | 985.5 | 341.8 |
| 1087.2 | 1.5 | 9.6 | 596.8 | 23.5 |
| 1307.5 | 1.7 | 9.2 | 581.3 | 29.6 |
| 1447.6 | 1.7 | 8.3 | 643.6 | 36.3 |

Total number of fragments = 146

Average ballistic density for all fragments = 709.8

Average gamma for all fragments = 10.655

Number of hazardous fragments in zone = 14

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 75-120°
Polar Zone 100-105°

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (tt/lb) |
|---|---|---|---|---|
| 3802.26 | 2.28 | 4.2 | 1108.1 | 188.8 |
| 2638.02 | 3.56 | 9.5 | 892.3 | 58.0 |
| 2758.14 | 3.35 | 8.5 | 450.6 | 67.6 |
| 7760.06 | 5.34 | 4.8 | 628.1 | 334.8 |
| 3243.24 | 3.98 | 8.6 | 407.9 | 78.5 |
| 1820.28 | 1.85 | 7.1 | 722.2 | 53.2 |
| 1695.54 | 1.69 | 7.0 | 771.0 | 50.5 |
| 1643.18 | 1.54 | 6.6 | 859.7 | 52.1 |
| 997.92 | 1.06 | 7.4 | 917.8 | 28.0 |
| 497.42 | .85 | 12.0 | 630.5 | 8.6 |
| 2105.18 | 1.84 | 6.1 | 842.3 | 71.5 |
| 580.58 | 1.16 | 14.0 | 462.1 | 8.6 |
| 529.76 | .87 | 11.5 | 651.1 | 9.6 |
| 489.72 | .97 | 13.9 | 510.3 | 7.3 |
| 443.52 | .83 | 13.0 | 590.7 | 7.1 |
| 651.42 | .85 | 9.1 | 831.4 | 14.8 |
| 539.00 | .87 | 11.3 | 662.5 | 9.9 |
| 478.94 | .76 | 11.1 | 720.2 | 8.9 |
| 397.32 | .63 | 11.0 | 803.3 | 7.5 |
| 386.54 | .62 | 11.2 | 798.1 | 7.2 |
| 346.50 | .66 | 13.4 | 639.7 | 5.4 |
| 1093.40 | 1.11 | 7.1 | 934.3 | 32.0 |
| 418.88 | .81 | 13.5 | 579.1 | 6.5 |
| 392.78 | .84 | 15.0 | 509.6 | 5.5 |
| 311.08 | .68 | 15.4 | 549.2 | 4.2 |
| 882.42 | 1.05 | 8.4 | 816.2 | 22.0 |
| 434.28 | .80 | 12.9 | 607.5 | 7.0 |
| 423.50 | .74 | 12.3 | 659.3 | 7.2 |
| 392.70 | .73 | 13.0 | 631.8 | 6.3 |
| 1449.14 | 1.74 | 8.4 | 629.0 | 35.8 |
| 1002.54 | 1.28 | 8.9 | 696.3 | 23.4 |
| 777.70 | 1.29 | 11.6 | 531.5 | 13.9 |
| 426.58 | .79 | 13.0 | 604.5 | 6.8 |
| 973.28 | 1.17 | 8.4 | 764.7 | 24.0 |
| 888.58 | 1.27 | 10.0 | 618.0 | 18.4 |
| 568.26 | 1.02 | 12.5 | 553.2 | 9.4 |
| 408.10 | .74 | 12.7 | 641.2 | 6.7 |
| 699.16 | 1.11 | 11.1 | 595.4 | 13.0 |
| 623.70 | .89 | 10.0 | 736.7 | 12.9 |
| 520.52 | .89 | 11.9 | 621.9 | 9.1 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 75-120°
Polar Zone 100-105°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 509.74 | .74 | 10.2 | 798.7 | 10.4 |
| 405.02 | .74 | 12.7 | 641.3 | 6.6 |
| 355.74 | .62 | 12.3 | 723.2 | 6.0 |
| 495.88 | .79 | 11.2 | 702.8 | 9.2 |
| 589.82 | .82 | 9.7 | 798.1 | 12.6 |
| 914.76 | 1.50 | 11.5 | 496.6 | 16.5 |
| 971.74 | 1.24 | 8.9 | 707.6 | 22.7 |
| 793.10 | 1.09 | 9.6 | 694.4 | 17.1 |
| 1110.34 | 1.32 | 8.3 | 735.3 | 27.8 |
| 494.34 | .98 | 13.9 | 510.6 | 7.4 |
| 1353.66 | 1.73 | 9.0 | 594.2 | 31.4 |
| 473.54 | .91 | 13.8 | 532.4 | 7.0 |
| 1021.02 | 1.29 | 8.9 | 695.3 | 24.0 |
| 1096.48 | 1.56 | 10.0 | 563.2 | 22.9 |
| 694.54 | 1.29 | 13.0 | 475.3 | 11.1 |
| 896.28 | 1.42 | 11.1 | 527.5 | 16.8 |
| 900.90 | 1.43 | 11.1 | 528.4 | 16.9 |
| 1466.08 | 2.01 | 9.6 | 516.4 | 31.9 |
| 2758.14 | 2.62 | 6.7 | 649.5 | 86.2 |
| 859.32 | 1.31 | 10.7 | 572.2 | 16.7 |
| 372.68 | .56 | 10.4 | 900.7 | 7.4 |
| 358.82 | .57 | 11.2 | 628.8 | 6.7 |
| 343.42 | .57 | 11.7 | 789.8 | 6.1 |
| 352.66 | .57 | 11.4 | 812.7 | 6.4 |

Total number of fragments = 64

Average ballistic density for all fragments = 663.7

Average gamma for all fragments = 10.536

Number of hazardous fragments in zone = 7

Fragment Weight Presented Area Data
Test No. QD-155-SC-2
(Interaction Fragment)
Azimuthal Zone 75-120°
Polar Zone 90-105°

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 3907.0 | 3.7 | 6.7 | 542.1 | 121.6 |
| 3802.3 | 2.3 | 4.2 | 1108.1 | 188.8 |
| 2450.1 | 2.6 | 7.5 | 572.4 | 67.7 |
| 7279.6 | 5.5 | 5.3 | 569.2 | 287.9 |
| 2638.0 | 3.6 | 9.5 | 392.3 | 58.0 |
| 2758.1 | 3.3 | 8.5 | 450.6 | 67.6 |
| 7760.1 | 5.3 | 4.8 | 628.1 | 334.8 |
| 3243.2 | 4.0 | 8.6 | 407.9 | 78.5 |
| 879.3 | 1.1 | 9.0 | 728.3 | 20.3 |
| 1820.3 | 1.9 | 7.1 | 722.2 | 53.2 |
| 1695.5 | 1.7 | 7.0 | 771.0 | 50.5 |
| 1643.2 | 1.5 | 6.6 | 859.7 | 52.1 |
| 997.9 | 1.1 | 7.4 | 917.8 | 28.0 |
| 1213.5 | 1.4 | 8.3 | 698.9 | 30.3 |
| 563.6 | .9 | 11.7 | 615.6 | 10.0 |
| 512.8 | 1.1 | 14.6 | 461.7 | 7.3 |
| 497.4 | .9 | 12.0 | 630.5 | 8.6 |
| 1074.9 | 1.2 | 8.0 | 794.5 | 28.1 |
| 2105.2 | 1.8 | 6.1 | 842.3 | 71.5 |
| 580.6 | 1.2 | 14.0 | 462.1 | 8.6 |
| 529.8 | .9 | 11.5 | 651.1 | 9.6 |
| 489.7 | 1.0 | 13.9 | 510.3 | 7.3 |
| 443.5 | .8 | 13.0 | 590.7 | 7.1 |
| 774.6 | 1.2 | 11.0 | 573.5 | 14.6 |
| 559.0 | .9 | 11.1 | 665.4 | 10.4 |
| 345.0 | .7 | 14.0 | 600.1 | 5.1 |
| 1033.3 | 1.2 | 7.8 | 831.5 | 27.4 |
| 651.4 | .8 | 9.1 | 831.4 | 14.8 |
| 539.0 | .9 | 11.3 | 662.5 | 9.9 |
| 476.9 | .8 | 11.1 | 720.2 | 8.9 |
| 397.3 | .6 | 11.0 | 803.3 | 7.5 |
| 386.5 | .6 | 11.2 | 798.1 | 7.2 |
| 346.5 | .7 | 13.4 | 639.7 | 5.4 |
| 1093.4 | 1.1 | 7.1 | 934.3 | 32.0 |
| 418.9 | .8 | 13.5 | 579.1 | 6.5 |
| 392.7 | .8 | 15.0 | 509.6 | 5.5 |
| 311.1 | .7 | 15.4 | 549.2 | 4.2 |
| 882.4 | 1.1 | 8.4 | 816.2 | 22.0 |
| 594.4 | .9 | 11.1 | 648.4 | 11.1 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
(Interaction Fragment)
Azimuthal Zone 75-120°
Polar Zone 90-105°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 563.6 | .8 | 9.7 | 821.9 | 12.1 |
| 314.2 | .6 | 13.8 | 641.4 | 4.7 |
| 434.3 | .8 | 12.9 | 607.5 | 7.8 |
| 423.5 | .7 | 12.3 | 659.3 | 7.2 |
| 392.7 | .7 | 13.0 | 631.8 | 6.3 |
| 620.6 | .9 | 10.4 | 701.1 | 12.4 |
| 383.5 | .7 | 12.1 | 712.9 | 6.6 |
| 2220.7 | 2.3 | 7.3 | 627.8 | 63.1 |
| 1501.5 | 1.8 | 8.6 | 602.9 | 36.5 |
| 1449.1 | 1.7 | 8.4 | 629.0 | 35.8 |
| 851.6 | 1.4 | 11.6 | 507.4 | 15.3 |
| 1002.5 | 1.3 | 8.9 | 696.3 | 23.4 |
| 777.7 | 1.3 | 11.6 | 531.5 | 13.9 |
| 426.6 | .8 | 13.0 | 604.5 | 6.8 |
| 973.3 | 1.2 | 8.4 | 764.7 | 24.0 |
| 888.6 | 1.3 | 10.0 | 618.0 | 18.4 |
| 568.3 | 1.0 | 12.5 | 553.2 | 9.4 |
| 426.6 | .8 | 12.5 | 639.1 | 7.1 |
| 986.7 | 1.2 | 8.3 | 782.1 | 24.8 |
| 380.4 | .7 | 12.1 | 712.7 | 6.5 |
| 355.7 | .6 | 11.9 | 757.9 | 6.2 |
| 308.0 | .6 | 12.9 | 716.4 | 4.9 |
| 321.9 | .6 | 13.1 | 692.4 | 5.1 |
| 408.1 | .7 | 12.7 | 641.2 | 6.7 |
| 845.5 | 1.0 | 8.2 | 850.1 | 21.3 |
| 525.1 | .9 | 11.6 | 647.6 | 9.4 |
| 699.2 | 1.1 | 11.1 | 595.4 | 13.0 |
| 623.7 | .9 | 10.0 | 736.7 | 12.9 |
| 520.5 | .9 | 11.9 | 621.9 | 9.1 |
| 509.7 | .7 | 10.2 | 798.7 | 10.4 |
| 405.0 | .7 | 12.7 | 641.3 | 6.6 |
| 355.7 | .6 | 12.3 | 723.2 | 6.0 |
| 569.8 | .8 | 10.1 | 762.9 | 11.7 |
| 472.8 | .9 | 13.2 | 561.8 | 7.5 |
| 495.9 | .8 | 11.2 | 702.8 | 9.2 |
| 669.9 | .9 | 9.3 | 792.5 | 14.9 |
| 642.2 | .8 | 9.3 | 821.5 | 14.4 |
| 446.6 | .8 | 11.9 | 675.1 | 7.8 |
| 311.1 | .7 | 14.9 | 577.7 | 4.3 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
(Interaction Fragment)
Azimuthal Zone 75-120°
Polar Zone 90-105°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 589.8 | .8 | 9.7 | 798.1 | 12.6 |
| 636.0 | 1.0 | 10.5 | 682.0 | 12.6 |
| 519.0 | .8 | 11.2 | 682.1 | 9.6 |
| 914.8 | 1.5 | 11.5 | 496.6 | 16.5 |
| 971.7 | 1.2 | 8.9 | 707.6 | 22.7 |
| 793.1 | 1.1 | 9.6 | 694.4 | 17.1 |
| 355.7 | .7 | 13.5 | 626.1 | 5.5 |
| 318.8 | .8 | 18.6 | 407.5 | 3.6 |
| 780.8 | 1.1 | 10.2 | 641.2 | 15.9 |
| 1110.3 | 1.3 | 8.3 | 735.3 | 27.8 |
| 494.3 | 1.0 | 13.9 | 510.6 | 7.4 |
| 1353.7 | 1.7 | 9.0 | 594.2 | 31.4 |
| 463.5 | .9 | 13.8 | 532.4 | 7.0 |
| 1107.3 | 1.8 | 11.3 | 463.3 | 20.4 |
| 709.9 | 1.3 | 13.0 | 467.7 | 11.3 |
| 1021.0 | 1.3 | 8.9 | 695.3 | 24.0 |
| 930.2 | 1.4 | 10.6 | 553.2 | 18.2 |
| 885.5 | 1.3 | 10.2 | 601.2 | 18.0 |
| 876.3 | 1.7 | 13.6 | 396.4 | 13.4 |
| 1646.3 | 2.5 | 10.5 | 423.2 | 32.6 |
| 1096.5 | 1.6 | 10.0 | 563.2 | 22.9 |
| 694.5 | 1.3 | 13.0 | 475.3 | 11.1 |
| 896.3 | 1.4 | 11.1 | 527.5 | 16.8 |
| 900.9 | 1.4 | 11.1 | 528.4 | 16.9 |
| 2927.5 | 2.7 | 6.4 | 664.1 | 94.7 |
| 1466.1 | 2.0 | 9.6 | 516.4 | 31.9 |
| 2758.1 | 2.6 | 6.7 | 649.5 | 86.2 |
| 1570.8 | 2.1 | 9.5 | 505.5 | 34.4 |
| 1966.6 | 2.2 | 7.8 | 607.9 | 52.5 |
| 859.3 | 1.3 | 10.7 | 572.2 | 16.7 |
| 372.7 | .6 | 10.4 | 900.7 | 7.4 |
| 358.8 | .6 | 11.2 | 828.8 | 6.7 |
| 343.4 | .6 | 11.7 | 789.8 | 6.1 |
| 352.7 | .6 | 11.4 | 812.7 | 6.4 |

Total number of fragments = 112

Average ballistic density for all fragments = 652,7

Average gamma for all fragments = 10.630

Number of hazardous fragments in zone = 12

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 75-120°
Polar Zone 60-120°

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 591.36 | .88 | 10.5 | 712.7 | 11.8 |
| 338.80 | .51 | 10.5 | 941.3 | 6.7 |
| 348.04 | .63 | 12.7 | 697.7 | 5.7 |
| 435.82 | .77 | 12.4 | 645.0 | 7.3 |
| 790.02 | 1.14 | 10.1 | 649.1 | 16.3 |
| 797.72 | 1.06 | 9.3 | 731.0 | 17.8 |
| 344.96 | .66 | 13.5 | 637.6 | 5.3 |
| 845.46 | 1.10 | 9.1 | 732.8 | 19.3 |
| 968.66 | 1.24 | 9.0 | 701.5 | 22.5 |
| 364.98 | .56 | 10.6 | 882.7 | 7.1 |
| 388.08 | .61 | 11.1 | 806.6 | 7.3 |
| 408.10 | .75 | 12.8 | 632.1 | 6.6 |
| 465.08 | .75 | 11.2 | 720.4 | 8.6 |
| 522.06 | .72 | 9.7 | 854.5 | 11.2 |
| 526.68 | .90 | 12.0 | 616.9 | 9.2 |
| 563.64 | .85 | 10.5 | 723.1 | 11.1 |
| 321.86 | .54 | 11.7 | 815.6 | 5.7 |
| 328.02 | .52 | 11.2 | 867.3 | 6.1 |
| 371.14 | .66 | 12.4 | 696.9 | 6.2 |
| 357.28 | .60 | 11.7 | 776.5 | 6.4 |
| 746.90 | .83 | 7.8 | 984.2 | 19.9 |
| 868.56 | .96 | 7.7 | 922.0 | 23.3 |
| 332.64 | .62 | 13.0 | 683.0 | 5.3 |
| 406.56 | .69 | 11.8 | 715.5 | 7.2 |
| 448.14 | .77 | 12.0 | 664.5 | 7.8 |
| 482.02 | .78 | 11.3 | 698.4 | 8.8 |
| 492.80 | .78 | 11.1 | 718.1 | 9.3 |
| 366.52 | .66 | 12.7 | 677.4 | 6.0 |
| 867.02 | 1.13 | 9.1 | 721.8 | 19.8 |
| 620.62 | .89 | 10.1 | 736.7 | 12.8 |
| 867.02 | 1.13 | 9.1 | 721.8 | 19.8 |
| 375.76 | .68 | 12.7 | 670.1 | 6.2 |
| 311.08 | .47 | 10.5 | 981.1 | 6.2 |
| 383.46 | .55 | 10.0 | 942.7 | 8.0 |
| 526.68 | .72 | 9.6 | 863.9 | 11.5 |
| 311.08 | .69 | 15.5 | 541.6 | 4.2 |
| 320.32 | .59 | 12.9 | 705.0 | 5.2 |
| 368.86 | .62 | 11.8 | 753.9 | 6.5 |
| 309.54 | .55 | 12.4 | 763.0 | 5.2 |
| 334.18 | .67 | 14.1 | 603.9 | 4.9 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 75-120°
Polar Zone 60-120°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 371.14 | .67 | 12.6 | 682.9 | 6.1 |
| 412.72 | .85 | 14.3 | 530.4 | 6.0 |
| 374.22 | .54 | 10.0 | 953.6 | 7.8 |
| 344.96 | .63 | 12.8 | 686.6 | 5.6 |
| 315.70 | .52 | 11.5 | 846.8 | 5.7 |
| 348.04 | .66 | 13.2 | 652.1 | 5.5 |
| 363.44 | .57 | 11.0 | 840.1 | 6.9 |
| 383.46 | .79 | 14.5 | 542.0 | 5.5 |
| 417.34 | .69 | 11.6 | 723.4 | 7.5 |
| 426.58 | .68 | 11.2 | 757.4 | 7.9 |
| 441.98 | .65 | 10.3 | 839.5 | 8.9 |
| 552.86 | .95 | 12.0 | 601.8 | 8.6 |
| 585.20 | .88 | 10.6 | 706.5 | 11.5 |
| 600.60 | .78 | 9.0 | 878.6 | 13.8 |
| 691.46 | .99 | 10.0 | 699.8 | 14.3 |
| 311.08 | .57 | 12.8 | 721.0 | 5.0 |
| 617.54 | 1.02 | 11.6 | 599.5 | 11.1 |
| 321.86 | .50 | 11.0 | 899.5 | 6.1 |
| 389.62 | .62 | 11.1 | 798.1 | 7.3 |
| 417.34 | .78 | 13.0 | 608.2 | 6.7 |
| 483.56 | .70 | 10.2 | 822.1 | 9.9 |
| 488.18 | .81 | 11.6 | 670.9 | 8.8 |
| 888.58 | 1.21 | 9.5 | 667.6 | 19.4 |
| 457.38 | .89 | 13.5 | 549.4 | 7.0 |
| 702.24 | 1.10 | 11.0 | 608.7 | 13.3 |
| 688.38 | .96 | 9.7 | 737.6 | 14.7 |
| 830.06 | 1.26 | 10.6 | 586.9 | 16.2 |
| 733.04 | 1.13 | 10.8 | 610.3 | 14.1 |
| 739.20 | 1.05 | 9.9 | 687.0 | 15.5 |
| 993.30 | 1.31 | 9.2 | 662.5 | 22.4 |
| 545.16 | .90 | 11.6 | 638.5 | 9.8 |
| 539.00 | .95 | 12.3 | 584.0 | 9.1 |
| 562.10 | 1.01 | 12.6 | 553.8 | 9.3 |
| 2018.94 | 1.90 | 6.6 | 778.9 | 63.7 |
| 2025.10 | 1.87 | 6.5 | 791.9 | 65.2 |
| 2057.44 | 1.83 | 6.2 | 831.1 | 68.7 |
| 1347.50 | 1.50 | 7.8 | 733.5 | 36.0 |
| 2266.88 | 2.28 | 7.0 | 658.5 | 67.0 |
| 1361.36 | 1.20 | 6.2 | 1035.6 | 45.9 |
| 3269.42 | 2.18 | 4.7 | 1015.7 | 145.7 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 75-120°
Polar Zone 60-120°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 1101.10 | 1.45 | 9.2 | 630.6 | 24.8 |
| 2810.50 | 4.64 | 11.6 | 281.2 | 50.6 |
| 1252.02 | 1.46 | 8.2 | 710.9 | 31.9 |
| 1635.48 | 1.41 | 6.0 | 978.6 | 56.4 |
| 1523.06 | 1.89 | 8.7 | 585.4 | 36.4 |
| 2601.06 | 2.00 | 5.4 | 919.6 | 100.5 |
| 6976.20 | 4.25 | 4.3 | 796.2 | 340.3 |
| 7007.00 | 3.83 | 3.8 | 933.6 | 380.6 |
| 5106.64 | 3.35 | 4.6 | 832.9 | 231.3 |
| 1185.80 | 1.30 | 7.7 | 800.0 | 32.1 |
| 1464.54 | 1.78 | 8.5 | 619.3 | 35.9 |
| 1650.88 | 1.85 | 7.8 | 656.1 | 43.8 |
| 1235.08 | 1.37 | 7.7 | 773.0 | 33.2 |
| 1305.92 | 1.28 | 6.9 | 898.3 | 39.5 |
| 6361.74 | 3.77 | 4.1 | 870.2 | 319.3 |
| 1550.78 | 1.44 | 6.5 | 895.9 | 49.6 |
| 1341.34 | 1.58 | 8.2 | 678.6 | 33.9 |
| 1464.54 | 1.75 | 8.4 | 632.6 | 36.4 |
| 1524.60 | 1.91 | 8.8 | 578.3 | 36.2 |
| 1734.04 | 2.10 | 8.5 | 569.8 | 42.5 |
| 2216.06 | 2.00 | 6.3 | 783.5 | 73.0 |
| 2899.82 | 2.19 | 5.3 | 893.7 | 114.0 |
| 3124.66 | 2.48 | 5.5 | 902.5 | 117.2 |
| 1538.46 | 1.77 | 8.0 | 655.2 | 39.8 |
| 2189.88 | 2.09 | 6.7 | 723.9 | 68.1 |
| 3635.94 | 2.58 | 5.0 | 875.7 | 152.1 |
| 2328.48 | 2.13 | 6.4 | 751.7 | 75.8 |
| 2152.92 | 2.32 | 7.5 | 610.6 | 59.5 |
| 3175.48 | 3.03 | 6.7 | 603.6 | 99.1 |
| 6292.44 | 3.44 | 3.8 | 985.5 | 341.8 |
| 1087.24 | 1.49 | 9.6 | 596.8 | 23.5 |
| 1307.46 | 1.72 | 9.2 | 581.3 | 29.6 |
| 1447.60 | 1.72 | 8.3 | 643.6 | 36.3 |
| 369.60 | .73 | 13.8 | 595.1 | 5.6 |
| 465.08 | .68 | 10.2 | 835.0 | 9.5 |
| 569.80 | .69 | 8.5 | 989.2 | 13.9 |
| 699.16 | 1.05 | 10.5 | 653.3 | 13.9 |
| 448.14 | .64 | 10.1 | 865.2 | 9.3 |
| 614.46 | .85 | 9.7 | 778.7 | 13.1 |
| 318.78 | .50 | 11.1 | 892.0 | 6.0 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 75-120°
Polar Zone 60-120°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 324.94 | .54 | 11.6 | 826.5 | 5.8 |
| 452.76 | .71 | 11.0 | 755.2 | 8.6 |
| 458.92 | .74 | 11.3 | 715.6 | 8.4 |
| 489.72 | .76 | 10.9 | 737.9 | 9.4 |
| 344.96 | .59 | 12.0 | 756.5 | 6.0 |
| 383.46 | .70 | 12.9 | 649.1 | 6.2 |
| 526.68 | .77 | 10.3 | 776.1 | 10.7 |
| 652.96 | .86 | 9.2 | 822.3 | 14.8 |
| 454.30 | .71 | 10.9 | 758.8 | 8.6 |
| 522.06 | .74 | 9.9 | 818.0 | 10.9 |
| 974.82 | 1.03 | 7.4 | 931.7 | 27.4 |
| 309.54 | .57 | 13.0 | 710.1 | 5.0 |
| 323.40 | .56 | 12.1 | 778.3 | 5.6 |
| 371.14 | .68 | 12.7 | 667.9 | 6.1 |
| 440.44 | .77 | 12.3 | 647.3 | 7.5 |
| 617.54 | .87 | 9.9 | 760.3 | 13.0 |
| 1044.12 | 1.33 | 8.9 | 681.4 | 24.4 |
| 531.30 | .75 | 9.9 | 821.4 | 11.2 |
| 548.24 | .77 | 9.8 | 812.5 | 11.6 |
| 318.78 | .64 | 14.1 | 620.5 | 4.7 |
| 358.82 | .54 | 10.6 | 902.0 | 7.1 |
| 518.98 | .74 | 10.0 | 813.4 | 10.8 |
| 745.36 | 1.05 | 9.8 | 694.5 | 15.7 |
| 617.54 | .91 | 10.3 | 710.2 | 12.4 |
| 391.16 | .63 | 11.2 | 791.4 | 7.3 |
| 394.24 | .60 | 10.7 | 846.5 | 7.7 |
| 434.28 | .72 | 11.7 | 703.7 | 7.7 |
| 651.42 | 1.16 | 12.4 | 522.4 | 10.9 |
| 791.56 | 1.04 | 9.2 | 750.4 | 18.0 |
| 526.68 | .94 | 12.5 | 576.3 | 8.8 |
| 599.06 | .86 | 10.1 | 750.1 | 12.4 |
| 341.88 | .57 | 11.7 | 795.8 | 6.1 |
| 617.54 | .73 | 8.3 | 980.8 | 15.4 |
| 318.78 | .56 | 12.4 | 751.1 | 5.3 |
| 443.52 | .67 | 10.5 | 812.9 | 8.8 |
| 372.68 | .78 | 14.6 | 543.7 | 5.3 |
| 338.80 | .51 | 10.5 | 940.9 | 6.7 |
| 563.64 | .76 | 9.5 | 845.7 | 12.4 |
| 1041.04 | 1.26 | 8.5 | 738.9 | 25.6 |
| 237.16 | .49 | 14.5 | 687.5 | 3.4 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 75-120°
Polar Zone 60-120°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 537.46 | .85 | 11.0 | 689.1 | 10.1 |
| 385.00 | .61 | 11.1 | 803.3 | 7.2 |
| 420.42 | .71 | 11.8 | 703.7 | 7.4 |
| 475.86 | .81 | 11.9 | 655.4 | 8.3 |
| 485.10 | .91 | 13.2 | 557.3 | 7.7 |
| 512.82 | .82 | 11.2 | 687.7 | 9.5 |
| 323.40 | .54 | 11.6 | 820.6 | 5.8 |
| 338.80 | .62 | 12.9 | 688.6 | 5.5 |
| 455.84 | .76 | 11.7 | 688.7 | 8.1 |
| 783.86 | 1.01 | 9.1 | 766.5 | 18.0 |
| 317.24 | .49 | 10.8 | 931.6 | 6.1 |
| 440.44 | .69 | 10.9 | 774.2 | 8.4 |
| 465.08 | .71 | 10.7 | 773.6 | 9.0 |
| 352.66 | .67 | 13.3 | 642.6 | 5.5 |
| 364.98 | .70 | 13.5 | 621.0 | 5.6 |
| 389.62 | .63 | 11.4 | 774.4 | 7.1 |
| 400.40 | .66 | 11.5 | 746.0 | 7.2 |
| 405.02 | .75 | 12.9 | 628.2 | 6.5 |
| 438.90 | .79 | 12.6 | 627.8 | 7.3 |
| 443.52 | .59 | 9.4 | 967.1 | 9.8 |
| 591.36 | .85 | 10.1 | 750.9 | 12.2 |
| 597.52 | .85 | 9.9 | 765.4 | 12.5 |
| 318.78 | .67 | 14.8 | 577.7 | 4.5 |
| 677.60 | 1.02 | 10.6 | 654.7 | 13.3 |
| 309.54 | .67 | 15.2 | 562.1 | 4.2 |
| 349.58 | .74 | 14.8 | 552.2 | 4.9 |
| 372.68 | .68 | 12.7 | 668.0 | 6.1 |
| 392.70 | .75 | 13.3 | 606.5 | 6.1 |
| 397.32 | .67 | 11.8 | 723.8 | 7.0 |
| 432.74 | .66 | 10.7 | 805.6 | 8.4 |
| 505.12 | .89 | 12.4 | 596.8 | 8.5 |
| 514.36 | .95 | 12.9 | 559.9 | 8.3 |
| 582.12 | .70 | 8.4 | 990.4 | 14.4 |
| 312.62 | .73 | 16.4 | 497.3 | 4.0 |
| 338.80 | .65 | 13.5 | 644.4 | 5.2 |
| 343.42 | .70 | 14.3 | 582.3 | 5.0 |
| 514.36 | .74 | 10.0 | 811.0 | 10.6 |
| 489.72 | .98 | 14.0 | 503.9 | 7.3 |
| 522.06 | .97 | 13.0 | 548.4 | 8.4 |
| 528.22 | .97 | 12.9 | 549.4 | 8.5 |

Fragment Weight Presented Area Data
Test No. QD-155-SC12
Azimuthal Zone 75-120°
Polar Zone 60-120°
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 489.72 | .89 | 12.8 | 580.4 | 8.0 |
| 991.76 | 1.31 | 9.2 | 664.8 | 22.4 |
| 786.94 | 1.13 | 10.0 | 657.1 | 16.3 |
| 386.54 | .80 | 14.5 | 537.7 | 5.5 |
| 676.06 | 1.06 | 11.0 | 616.6 | 12.8 |
| 1054.90 | 1.29 | 8.6 | 720.7 | 25.6 |
| 1033.34 | 1.23 | 8.3 | 762.0 | 25.9 |
| 1008.70 | 1.32 | 9.1 | 667.6 | 23.0 |
| 189.42 | 1.41 | 52.2 | 112.8 | .8 |
| 813.12 | 1.32 | 11.4 | 533.9 | 14.8 |
| 956.34 | 1.30 | 9.5 | 647.1 | 20.9 |
| 415.80 | .74 | 12.5 | 649.3 | 6.9 |
| 417.34 | .67 | 11.2 | 761.4 | 7.7 |
| 808.50 | 1.04 | 9.0 | 760.8 | 18.7 |
| 392.70 | .88 | 15.6 | 479.4 | 5.2 |
| 962.50 | 1.25 | 9.1 | 690.2 | 22.1 |
| 1001.00 | 1.23 | 8.6 | 731.4 | 24.2 |
| 632.94 | 1.20 | 13.3 | 482.1 | 9.9 |
| 696.08 | 1.03 | 10.3 | 669.4 | 14.0 |
| 779.24 | 1.32 | 11.9 | 513.2 | 13.7 |
| 559.02 | 1.00 | 12.5 | 561.3 | 9.3 |
| 928.62 | 1.21 | 9.1 | 699.1 | 21.2 |
| 1064.14 | 1.42 | 9.3 | 631.7 | 23.8 |
| 705.32 | 1.16 | 11.5 | 564.6 | 12.7 |
| 930.16 | 1.33 | 10.0 | 603.2 | 19.3 |
| 480.48 | .97 | 14.1 | 504.4 | 7.1 |
| 743.82 | 1.07 | 10.0 | 675.4 | 15.4 |

Total number of fragments = 228

Average ballistic density for all fragments = 716.0

Average gamma for all fragments = 10.725

Number of hazardous fragments in zone = 19

Fragment Hole Count Data
Test No. QD-155-SC12

| Azimuthal Zone (°) | Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°) |
|---|---|
| 180 - 190 | 342 |
| 190 - 200 | 61 |
| 200 - 210 | 31 |
| 210 - 220 | 28 |
| 220 - 230 | 155 |
| 230 - 240 | 369 |
| 240 - 250 | 392 |
| 250 - 260 | 377 |
| 260 - 270 | 269 |
| 270 - 280 | 135 |
| 280 - 290 | 108 |
| 290 - 300 | 85 |
| 300 - 310 | 144 |
| 310 - 320 | 194 |
| 320 - 330 | 178 |
| 330 - 340 | 126 |
| 340 - 350 | 53 |
| 350 - 360 | 55 |

FAR-FIELD FRAGMENT COLLECTION DATA
FOR DETONATION OF EIGHT SINGLE PALLETS

Location: White Sands Missile Range, NM

Date: 8 August 1979

Collection Zone: Azimuth: 360°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 4524.52 | 2.85 | 4.4 | 940.4 | 213.4 |
| 1047.20 | 1.47 | 9.8 | 589.6 | 22.2 |
| 27750.80 | 11.58 | 2.9 | 704.7 | 1976.9 |
| 3538.92 | 3.35 | 6.6 | 577.2 | 111.1 |
| 1607.76 | 2.00 | 8.7 | 568.4 | 38.4 |
| 3870.02 | 4.18 | 7.6 | 452.8 | 106.5 |
| 7002.38 | 6.25 | 6.2 | 448.2 | 233.1 |
| 44.66 | .15 | 24.0 | 746.2 | .4 |
| 2140.60 | 2.56 | 8.4 | 522.6 | 53.2 |
| 3629.78 | 3.10 | 6.0 | 665.0 | 126.3 |
| 3894.66 | 3.80 | 6.8 | 525.8 | 118.6 |
| 4938.78 | 4.54 | 6.4 | 510.5 | 159.6 |
| 5202.12 | 5.03 | 6.8 | 461.1 | 159.9 |
| 5562.48 | 5.00 | 6.3 | 497.5 | 183.9 |
| 10197.88 | 7.40 | 5.1 | 506.6 | 417.6 |
| 23352.56 | 13.35 | 4.0 | 478.8 | 1213.8 |
| 999.46 | 1.39 | 9.7 | 612.1 | 21.4 |
| 1041.04 | 1.36 | 9.2 | 654.7 | 23.6 |
| 2460.92 | 2.63 | 7.5 | 478.6 | 68.6 |
| 280.28 | .54 | 13.5 | 702.5 | 4.3 |
| 364.98 | .58 | 11.0 | 835.9 | 6.9 |
| 372.68 | .65 | 12.2 | 711.0 | 6.3 |
| 411.18 | .74 | 12.5 | 650.6 | 6.8 |
| 420.42 | .64 | 10.7 | 816.6 | 8.2 |
| 497.42 | .91 | 12.8 | 571.9 | 8.1 |
| 523.60 | 1.00 | 13.4 | 521.1 | 8.1 |
| 602.14 | 1.10 | 12.8 | 522.5 | 9.8 |
| 740.74 | .91 | 8.6 | 857.9 | 18.0 |
| 891.66 | 1.31 | 10.3 | 592.9 | 18.0 |
| 1784.86 | 1.92 | 7.5 | 672.6 | 49.4 |
| 150.92 | .34 | 15.8 | 756.5 | 2.0 |
| 246.40 | .46 | 12.9 | 801.3 | 4.0 |
| 255.64 | .49 | 13.4 | 744.4 | 4.0 |
| 260.26 | .54 | 14.4 | 661.7 | 3.7 |
| 280.28 | .61 | 15.2 | 593.1 | 3.8 |
| 292.60 | .48 | 11.4 | 888.3 | 5.3 |

FAR-FIELD FRAGMENT COLLECTION DATA
FOR DETONATION OF EIGHT SINGLE PALLETS
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 360.36 | .59 | 11.4 | 804.1 | 6.6 |
| 372.68 | .84 | 15.7 | 487.8 | 4.9 |
| 432.74 | .74 | 12.0 | 675.9 | 7.5 |
| 435.82 | .74 | 12.0 | 677.8 | 7.6 |
| 466.62 | .89 | 13.3 | 559.9 | 7.3 |
| 512.82 | .80 | 10.9 | 721.6 | 9.8 |
| 565.18 | 1.08 | 13.3 | 506.7 | 8.8 |
| 697.62 | 1.05 | 10.6 | 644.4 | 13.7 |
| 709.94 | 1.02 | 10.0 | 690.3 | 14.7 |
| 716.10 | .85 | 8.3 | 912.7 | 17.9 |
| 811.58 | 1.46 | 12.6 | 459.0 | 13.4 |
| 868.56 | 1.19 | 9.6 | 671.1 | 18.9 |
| 903.98 | 1.31 | 10.2 | 601.1 | 18.5 |
| 1036.42 | 1.18 | 7.9 | 811.6 | 27.1 |
| 1316.70 | 2.03 | 10.8 | 454.1 | 25.3 |
| 1795.64 | 1.85 | 7.2 | 713.6 | 51.8 |
| 1855.70 | 1.47 | 5.5 | 1044.7 | 69.8 |
| 2356.20 | 1.81 | 5.4 | 968.9 | 91.2 |
| 2457.84 | 1.77 | 5.0 | 1046.7 | 101.6 |
| 101.64 | .28 | 19.2 | 689.9 | 1.1 |
| 161.70 | .38 | 16.3 | 702.1 | 2.1 |
| 163.24 | .34 | 14.7 | 814.8 | 2.3 |
| 212.52 | .47 | 15.4 | 663.1 | 2.9 |
| 224.84 | .56 | 17.4 | 537.1 | 2.7 |
| 260.26 | .59 | 15.8 | 578.4 | 3.4 |
| 267.96 | .64 | 16.6 | 526.9 | 3.3 |
| 287.98 | .63 | 15.3 | 574.0 | 3.9 |
| 303.38 | .60 | 13.9 | 648.0 | 4.5 |
| 351.12 | .64 | 12.8 | 679.8 | 5.7 |
| 358.82 | .71 | 13.9 | 596.1 | 5.4 |
| 368.06 | .74 | 14.0 | 582.9 | 5.5 |
| 377.30 | .73 | 13.5 | 608.9 | 5.8 |
| 431.20 | .90 | 14.7 | 500.9 | 6.1 |
| 446.60 | .87 | 13.7 | 545.6 | 6.8 |
| 514.36 | .98 | 13.4 | 529.3 | 8.0 |
| 629.86 | 1.21 | 13.4 | 475.5 | 9.8 |
| 632.94 | 1.18 | 13.0 | 496.8 | 10.1 |
| 897.82 | 1.46 | 11.3 | 511.5 | 16.5 |
| 922.46 | 1.48 | 11.2 | 511.2 | 17.1 |
| 1062.60 | 1.40 | 9.2 | 643.3 | 24.0 |
| 1239.70 | 1.67 | 9.4 | 576.1 | 27.4 |
| 1321.32 | 1.45 | 7.7 | 756.8 | 35.8 |

FAR-FIELD FRAGMENT COLLECTION DATA
FOR DETONATION OF EIGHT SINGLE PALLETS
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 2605.68 | 1.87 | 5.0 | 1021.7 | 108.1 |
| 1433.74 | 1.18 | 5.8 | 1113.8 | 51.6 |
| 2037.42 | 2.05 | 7.0 | 694.1 | 60.2 |
| 3985.52 | 2.65 | 4.7 | 923.9 | 178.1 |
| 679.14 | 1.05 | 10.8 | 633.6 | 13.1 |
| 702.24 | 1.05 | 10.5 | 649.6 | 13.9 |
| 984.06 | 2.08 | 14.8 | 326.9 | 13.8 |
| 2120.58 | 1.95 | 6.4 | 778.8 | 68.5 |
| 2427.04 | 2.23 | 6.4 | 727.2 | 78.4 |
| 5299.14 | 4.23 | 5.6 | 608.4 | 197.1 |
| 9681.98 | 5.40 | 3.9 | 771.6 | 515.8 |
| 3481.94 | 2.23 | 4.5 | 1043.3 | 161.3 |
| 4082.54 | 5.30 | 9.1 | 334.6 | 93.4 |
| 2225.30 | 1.96 | 6.2 | 812.0 | 75.1 |
| 731.50 | .92 | 8.8 | 826.8 | 17.3 |
| 4820.20 | 2.65 | 3.8 | 1117.4 | 260.5 |
| 645.26 | 1.05 | 11.4 | 602.1 | 11.8 |
| 922.46 | 1.58 | 12.0 | 466.2 | 16.0 |
| 1507.66 | 1.67 | 7.7 | 700.7 | 40.5 |
| 6474.16 | 2.45 | 2.6 | 1688.2 | 508.4 |
| 1461.46 | 1.73 | 8.3 | 640.4 | 36.6 |
| 426.58 | .87 | 14.3 | 523.4 | 6.2 |
| 2530.22 | 2.82 | 7.8 | 535.2 | 67.5 |
| 2551.78 | 1.84 | 5.0 | 1022.4 | 105.2 |
| 662.20 | 1.24 | 13.1 | 480.4 | 10.5 |
| 883.96 | 1.40 | 11.1 | 531.3 | 16.5 |
| 4458.30 | 6.15 | 9.7 | 292.3 | 96.0 |
| 1530.76 | 1.83 | 8.4 | 618.3 | 38.0 |
| 1958.88 | 3.13 | 11.2 | 353.7 | 36.4 |
| 8624.00 | 8.09 | 6.6 | 374.8 | 273.2 |
| 23911.58 | 15.17 | 4.4 | 404.7 | 1119.9 |
| 1290.52 | 2.03 | 11.0 | 446.2 | 24.4 |
| 4826.36 | 2.69 | 3.9 | 1093.9 | 257.3 |
| 11371.36 | 5.67 | 3.5 | 842.2 | 677.7 |
| 21673.96 | 11.21 | 3.6 | 577.5 | 1245.2 |
| 586.74 | 1.83 | 21.8 | 237.1 | 5.6 |
| 1321.32 | 1.55 | 8.2 | 684.7 | 33.5 |
| 1650.92 | 1.12 | 4.6 | 1433.0 | 76.1 |
| 542.08 | .88 | 11.4 | 653.8 | 9.9 |
| 776.16 | 1.26 | 11.4 | 547.7 | 14.2 |
| 782.32 | 1.15 | 10.3 | 637.8 | 15.9 |
| 947.10 | 1.47 | 10.9 | 530.7 | 18.1 |

FAR-FIELD FRAGMENT COLLECTION DATA
FOR DETONATION OF EIGHT SINGLE PALLETS
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 950.18 | 1.21 | 8.9 | 711.7 | 22.1 |
| 1004.08 | 1.51 | 10.5 | 540.6 | 19.8 |
| 1178.10 | 1.68 | 10.0 | 539.9 | 24.5 |
| 1409.10 | 1.77 | 8.8 | 600.1 | 33.4 |
| 1424.50 | 1.73 | 8.5 | 624.2 | 34.8 |
| 1456.84 | 1.20 | 5.8 | 1108.3 | 52.6 |
| 1613.92 | 1.42 | 6.1 | 957.2 | 54.6 |
| 2251.48 | 2.50 | 7.8 | 569.6 | 60.3 |
| 1315.16 | 1.66 | 8.8 | 614.9 | 31.0 |
| 1479.94 | 1.74 | 8.2 | 644.8 | 37.4 |
| 1652.42 | 2.08 | 8.8 | 550.8 | 39.0 |
| 1667.82 | 1.80 | 7.6 | 690.6 | 45.9 |
| 3144.68 | 2.07 | 4.6 | 1058.5 | 142.2 |
| 3304.84 | 2.86 | 6.1 | 683.3 | 113.5 |
| 6962.34 | 6.30 | 6.3 | 440.3 | 228.6 |
| 1262.80 | 2.34 | 13.0 | 352.8 | 20.2 |
| 940.94 | 1.11 | 8.3 | 801.8 | 23.6 |
| 1041.04 | 1.57 | 10.5 | 531.1 | 20.6 |
| 1084.16 | 1.59 | 10.3 | 540.0 | 21.9 |
| 1325.94 | 1.47 | 7.8 | 744.0 | 35.5 |
| 1798.72 | 1.60 | 6.2 | 887.1 | 60.0 |
| 1829.52 | 2.07 | 7.9 | 613.4 | 48.0 |
| 1888.04 | 1.95 | 7.2 | 693.4 | 54.3 |
| 4442.90 | 4.54 | 7.1 | 459.6 | 129.3 |
| 5117.42 | 3.83 | 5.2 | 683.3 | 203.3 |
| 25302.20 | 11.79 | 3.3 | 624.9 | 1613.2 |
| 28665.56 | 11.70 | 2.9 | 716.3 | 2086.9 |
| 606.76 | .97 | 11.2 | 632.9 | 11.3 |
| 850.08 | 1.24 | 10.2 | 615.6 | 17.3 |
| 970.20 | 1.27 | 9.1 | 680.3 | 22.1 |
| 1105.72 | 1.54 | 9.7 | 580.4 | 23.6 |
| 1256.64 | 1.71 | 9.5 | 562.0 | 27.4 |
| 2282.28 | 1.24 | 3.8 | 1652.9 | 124.8 |
| 5134.36 | 5.45 | 7.4 | 403.5 | 143.7 |
| 7465.92 | 6.24 | 5.9 | 479.0 | 265.4 |
| 13353.34 | 12.83 | 6.7 | 290.5 | 412.9 |
| 28596.26 | 12.51 | 3.1 | 646.3 | 1942.3 |
| 39782.82 | 21.58 | 3.8 | 397.0 | 2179.7 |
| 585.20 | .80 | 9.5 | 825.5 | 12.8 |
| 1402.94 | 1.35 | 6.7 | 894.4 | 43.3 |
| 1492.26 | 2.28 | 10.7 | 433.5 | 29.0 |
| 645.26 | 1.08 | 11.7 | 578.6 | 11.5 |

FAR-FIELD FRAGMENT COLLECTION DATA
FOR DETONATION OF EIGHT SINGLE PALLETS
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 1121.12 | 1.96 | 12.3 | 407.3 | 19.0 |
| 2168.32 | 4.78 | 15.4 | 207.5 | 29.2 |
| 2382.38 | 2.68 | 7.9 | 543.0 | 62.9 |
| 2835.14 | 3.23 | 8.0 | 488.4 | 73.9 |
| 8483.86 | 7.50 | 6.2 | 413.0 | 285.2 |
| 10291.82 | 8.24 | 5.6 | 435.1 | 382.0 |
| 4070.22 | 2.86 | 4.9 | 841.5 | 172.1 |
| 2003.54 | 2.28 | 8.0 | 582.0 | 52.3 |
| 5021.94 | 2.90 | 4.0 | 1016.9 | 258.4 |
| 623.70 | 1.32 | 14.8 | 411.6 | 8.8 |
| 805.42 | 1.67 | 14.5 | 373.0 | 11.5 |
| 714.56 | 1.25 | 12.2 | 513.9 | 12.2 |
| 1287.44 | 1.42 | 7.7 | 763.5 | 34.8 |
| 3820.74 | 4.30 | 7.9 | 428.5 | 100.9 |
| 9309.30 | 5.56 | 4.2 | 710.4 | 463.3 |
| 762.30 | 1.17 | 10.8 | 601.2 | 14.7 |
| 924.00 | 1.64 | 12.4 | 440.8 | 15.5 |
| 1801.80 | 3.67 | 14.2 | 256.6 | 26.3 |
| 20066.20 | 8.47 | 3.0 | 814.5 | 1413.1 |
| 21604.66 | 10.03 | 3.3 | 679.8 | 1382.3 |
| 799.26 | 1.20 | 10.5 | 609.9 | 15.9 |
| 1638.56 | 1.83 | 7.8 | 660.1 | 43.5 |
| 2608.76 | 2.48 | 6.6 | 670.0 | 81.7 |
| 2109.80 | 2.65 | 8.8 | 489.1 | 49.9 |
| 3817.66 | 4.87 | 8.9 | 355.6 | 89.0 |
| 300.30 | .75 | 17.6 | 459.4 | 3.6 |
| 451.22 | .68 | 10.6 | 799.2 | 8.9 |
| 643.72 | 1.14 | 12.4 | 529.0 | 10.8 |
| 994.84 | 1.23 | 8.6 | 731.8 | 24.0 |
| 2713.48 | 1.99 | 5.1 | 964.5 | 109.8 |
| 693.00 | 1.23 | 12.5 | 505.7 | 11.6 |
| 887.04 | 1.68 | 13.2 | 408.6 | 13.9 |
| 1298.22 | 1.62 | 8.7 | 631.6 | 31.0 |
| 790.02 | 1.39 | 12.3 | 481.4 | 13.3 |
| 292.60 | .80 | 19.1 | 409.2 | 3.2 |
| 535.92 | 1.16 | 15.2 | 428.5 | 7.4 |
| 686.84 | .76 | 7.8 | 1030.3 | 18.4 |
| 768.46 | 1.89 | 17.2 | 295.2 | 9.3 |
| 1338.26 | 2.43 | 12.7 | 354.4 | 21.9 |
| 5419.26 | 4.98 | 6.4 | 488.4 | 175.4 |
| 571.34 | .81 | 9.9 | 789.4 | 12.0 |
| 1051.82 | 1.23 | 8.2 | 774.9 | 26.8 |

FAR-FIELD FRAGMENT COLLECTION DATA
FOR DETONATION OF EIGHT SINGLE PALLETS
(Continued)

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 1062.60 | 1.44 | 9.5 | 615.1 | 23.3 |
| 774.62 | 1.40 | 12.6 | 468.2 | 12.7 |
| 984.06 | 1.91 | 13.6 | 372.3 | 15.1 |
| 4190.34 | 3.68 | 6.1 | 594.8 | 142.0 |
| 753.06 | 1.29 | 12.0 | 515.0 | 13.1 |
| 796.18 | 1.36 | 11.9 | 504.2 | 13.9 |
| 1208.90 | 1.50 | 8.7 | 659.7 | 29.0 |
| 1467.62 | 2.14 | 10.2 | 468.8 | 29.9 |
| 2363.90 | 4.50 | 13.3 | 247.6 | 36.9 |
| 2596.44 | 2.58 | 7.0 | 625.3 | 77.5 |
| 25872.00 | 13.68 | 3.7 | 511.6 | 1454.4 |
| 13679.82 | 6.73 | 3.4 | 783.5 | 826.2 |
| 9021.32 | 6.31 | 4.9 | 569.1 | 383.2 |
| 1635.48 | 2.41 | 10.3 | 437.1 | 33.0 |
| 47193.30 | 20.28 | 3.0 | 516.7 | 3263.3 |
| 354.20 | .62 | 12.3 | 724.4 | 6.0 |
| 902.44 | 1.70 | 13.2 | 408.1 | 14.3 |
| 1618.54 | 2.14 | 9.3 | 517.0 | 36.4 |
| 16570.40 | 12.28 | 5.2 | 385.1 | 664.4 |
| 23281.72 | 14.63 | 4.4 | 416.1 | 1100.9 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION

Location: White Sands Missile Range, NM

Date: 26 September 1979

Collection Zone: Azimuth: 0-20°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | No. Fragment | Fragment Wt. (gr) | Average Wt. (gr) |
|---|---|---|---|
| 0 - 300 | 229 | 25637.9 | 112.0 |
| 300 - 500 | 27 | 10935.5 | 405.0 |
| 500 - 600 | 10 | 5382.3 | 538.2 |
| 600 - 700 | 10 | 6460.3 | 646.0 |
| 700 - 800 | 11 | 8183.6 | 744.0 |
| 800 - 900 | 4 | 3494.3 | 873.6 |
| 900 - 1000 | 3 | 2853.6 | 951.2 |
| 1000 - 1200 | 14 | 15369.2 | 1097.8 |
| 1200 - 1400 | 7 | 9130.7 | 1304.4 |
| 1400 - 1700 | 9 | 13421.1 | 1491.2 |
| 1700 - 2000 | 4 | 7447.4 | 1861.9 |
| 2000 - 2500 | 5 | 10490.5 | 2098.1 |
| 2500 - 3000 | 1 | 2752.0 | 2752.0 |
| 3000+ | 16 | 110355.4 | 6928.5 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

Location: White Sands Missile Range, NM

Date: 26 September 1979

Collection Zone: Azimuth: 70-80°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | No. Fragment | Fragment Wt. (gr) | Average Wt. (gr) |
|---|---|---|---|
| 0 - 300 | 1080 | 90419.6 | 83.7 |
| 300 - 500 | 88 | 34212.6 | 388.8 |
| 500 - 600 | 25 | 13652.1 | 546.1 |
| 600 - 700 | 16 | 10234.8 | 639.7 |
| 700 - 800 | 15 | 11161.9 | 744.1 |
| 800 - 900 | 16 | 13496.6 | 843.5 |
| 900 - 1000 | 9 | 8428.4 | 936.5 |
| 1000 - 1200 | 4 | 4570.7 | 1142.7 |
| 1200 - 1400 | 11 | 14269.6 | 1297.2 |
| 1400 - 1700 | 7 | 10673.7 | 1524.8 |
| 1700 - 2000 | 4 | 7327.3 | |
| 2000 - 2500 | 11 | 24944.9 | 2267.7 |
| 2500 - 3000 | 4 | 10732.3 | 2683.1 |
| 3000+ | 12 | 63095.3 | 5257.9 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

Location: White Sands Missile Range, NM

Date: 26 September 1979

Collection Zone: Azimuth: 90-95°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | No. Fragment | Fragment Wt. (gr) | Average Wt. (gr) |
|---|---|---|---|
| 0 - 308 | 514 | 47941.8 | 93.3 |
| 308 - 500 | 69 | 27060.9 | 392.2 |
| 500 - 600 | 15 | 8356.0 | 557.1 |
| 600 - 700 | 17 | 11112.6 | 653.7 |
| 700 - 800 | 5 | 3888.5 | 777.7 |
| 800 - 900 | 9 | 7797.0 | 866.3 |
| 900 - 1000 | 4 | 3839.2 | 959.8 |
| 1000 - 1200 | 10 | 11057.2 | 1105.7 |
| 1200 - 1400 | 6 | 7522.9 | 1253.8 |
| 1400 - 1700 | 14 | 21567.7 | 1540.6 |
| 1700 - 2000 | 2 | 3739.1 | 1869.6 |
| 2000 - 2500 | 4 | 8987.4 | 2246.9 |
| 2500 - 3000 | 3 | 8463.8 | 2821.3 |
| 3000+ | 14 | 87926.3 | 6280.4 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

Location: White Sands Missile Range, NM

Date: 26 September 1979

Collection Zone: Azimuth: 90-100°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | No. Fragment | Fragment Wt. (gr) | Average Wt. (gr) |
|---|---|---|---|
| 0 - 308 | 919 | 88642.5 | 96.5 |
| 308 - 500 | 111 | 43716.0 | 393.8 |
| 500 - 600 | 24 | 13276.3 | 553.2 |
| 600 - 700 | 22 | 14322.0 | 651.0 |
| 700 - 800 | 11 | 8451.5 | 768.3 |
| 800 - 900 | 10 | 8593.2 | 859.3 |
| 900 - 1000 | 6 | 5770.4 | 961.7 |
| 1000 - 1200 | 19 | 21130.3 | 1112.1 |
| 1200 - 1400 | 11 | 13892.3 | 1262.9 |
| 1400 - 1700 | 21 | 31970.4 | 1522.4 |
| 1700 - 2000 | 5 | 9110.6 | 1822.1 |
| 2000 - 2500 | 8 | 18614.0 | 2326.7 |
| 2500 - 3000 | 7 | 19059.0 | 2722.7 |
| 3000+ | 28 | 180686.7 | 6453.1 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

Location: White Sands Missile Range, NM

Date: 26 September 1979

Collection Zone: Azimuth: 0-180°
Range: 700 to 900 ft

| Fragment Wt. (gr) | No. Fragment | Fragment Wt. (gr) | Average Wt. (gr) |
|---|---|---|---|
| 0 - 300 | 1331 | 150479.6 | 113.1 |
| 300 - 500 | 150 | 60494.3 | 403.3 |
| 500 - 600 | 50 | 27302.7 | 546.1 |
| 600 - 700 | 37 | 24013.2 | 649.0 |
| 700 - 800 | 16 | 11902.7 | 743.9 |
| 800 - 900 | 19 | 16190.0 | 852.1 |
| 900 - 1000 | 15 | 14463.7 | 964.2 |
| 1000 - 1200 | 23 | 25633.3 | 1114.5 |
| 1200 - 1400 | 12 | 15715.7 | 1309.6 |
| 1400 - 1700 | 24 | 36568.8 | 1523.7 |
| 1700 - 2000 | 9 | 16738.3 | 1859.8 |
| 2000 - 2500 | 16 | 35433.9 | 2214.6 |
| 2500 - 3000 | 11 | 30051.6 | 2732.0 |
| 3000+ | 40 | | |

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

Location: White Sands Missile Range, NM

Date: 26 September 1979

Collection Zone: Azimuth: 0-180°
Range: 900 to 1100 ft

| Fragment Wt. (gr) | No. Fragment | Fragment Wt. (gr) | Average Wt. (gr) |
|---|---|---|---|
| 0 - 300 | 558 | 75828.1 | 135.9 |
| 300 - 500 | 143 | 55418.4 | 387.5 |
| 500 - 600 | 45 | 24672.3 | 548.3 |
| 600 - 700 | 22 | 14277.3 | 649.0 |
| 700 - 800 | 20 | 14996.5 | 749.8 |
| 800 - 900 | 18 | 15393.8 | 855.2 |
| 900 - 1000 | 19 | 18184.3 | 957.1 |
| 1000 - 1200 | 22 | 24301.2 | 1104.6 |
| 1200 - 1400 | 15 | 19276.2 | 1285.1 |
| 1400 - 1700 | 11 | 16923.1 | 1538.5 |
| 1700 - 2000 | 6 | 10900.1 | 1816.7 |
| 2000 - 2500 | 12 | 27174.8 | 2264.6 |
| 2500 - 3000 | 7 | 19171.5 | 2738.8 |
| 3000+ | 32 | 255473.7 | 7983.6 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

Location: White Sands Missile Range, NM

Date: 26 September 1979

Collection Zone: Azimuth: 0-180°
Range: 1100 to 1500 ft

| Fragment Wt. (gr) | No. Fragment | Fragment Wt. (gr) | Average Wt. (gr) |
|---|---|---|---|
| 0 - 300 | 283 | 48180.4 | 170.2 |
| 300 - 500 | 149 | 58749.5 | 394.3 |
| 500 - 600 | 30 | 16515.0 | 550.5 |
| 600 - 700 | 33 | 21191.9 | 642.2 |
| 700 - 800 | 29 | 21778.7 | 751.0 |
| 800 - 900 | 14 | 11918.1 | 851.3 |
| 900 - 1000 | 23 | 21901.9 | 952.3 |
| 1000 - 1200 | 24 | 26756.0 | 1114.8 |
| 1200 - 1400 | 24 | 31311.3 | 1304.6 |
| 1400 - 1700 | 33 | 50321.0 | 1524.9 |
| 1700 - 2000 | 9 | 16270.1 | 1807.8 |
| 2000 - 2500 | 17 | 38704.8 | 2276.8 |
| 2500 - 3000 | 10 | 27093.2 | 2709.3 |
| 3000+ | 47 | 313299.1 | 6665.9 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

Location: White Sands Missile Range, NM

Date: 26 September 1979

Collection Zone: Azimuth: 0-180°
Range: 1500 to 1900 ft

| Fragment Wt. (gr) | No. Fragment | Fragment Wt. (gr) | Average Wt. (gr) |
|---|---|---|---|
| 0 - 300 | 55 | 8350.0 | 151.8 |
| 300 - 500 | 28 | 12061.3 | 430.8 |
| 500 - 600 | 12 | 6558.9 | 546.6 |
| 600 - 700 | 7 | 4496.8 | 642.4 |
| 700 - 800 | 7 | 5322.2 | 760.3 |
| 800 - 900 | 4 | 3341.8 | 835.4 |
| 900 - 1000 | 4 | 3759.1 | 939.8 |
| 1000 - 1200 | 10 | 10912.4 | 1091.2 |
| 1200 - 1400 | 11 | 14067.9 | 1278.9 |
| 1400 - 1700 | 8 | 12087.5 | 1510.9 |
| 1700 - 2000 | 6 | 11200.4 | 1866.7 |
| 2000 - 2500 | 8 | 18441.5 | 2305.2 |
| 2500 - 3000 | 4 | 11363.7 | 2840.9 |
| 3000+ | 20 | 173725.9 | 8686.3 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

Location: White Sands Missile Range, NM

Date: 26 September 1979

Collection Zone: Azimuth: 0-180°
Range: 1900 to 2300 ft

| Fragment Wt. (gr) | No. Fragment | Fragment Wt. (gr) | Average Wt. (gr) |
|---|---|---|---|
| 0 - 300 | 13 | 1911.1 | 147.0 |
| 300 - 500 | 6 | 2310.0 | 385.0 |
| 500 - 600 | 0 | 0.0 | 0.0 |
| 600 - 700 | 1 | 640.6 | 640.6 |
| 700 - 800 | 1 | 782.3 | 782.3 |
| 800 - 900 | 1 | 882.4 | 882.4 |
| 900 - 1000 | 1 | 959.4 | 959.4 |
| 1000 - 1200 | 3 | 3275.6 | 1091.9 |
| 1200 - 1400 | 3 | 4084.1 | 1361.4 |
| 1400 - 1700 | 4 | 6451.1 | 1612.8 |
| 1700 - 2000 | 1 | 1958.9 | 1958.9 |
| 2000 - 2500 | 6 | 13197.8 | 2199.6 |
| 2500 - 3000 | 1 | 2662.7 | 2662.7 |
| 3000+ | 10 | 70687.5 | 7068.8 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 311.1 | .511 | 11.499 | 851.6 | 5.6 |
| 321.9 | .663 | 14.419 | 596.2 | 4.6 |
| 331.1 | .603 | 12.748 | 707.1 | 5.4 |
| 365.0 | .667 | 12.792 | 670.0 | 5.9 |
| 445.1 | .718 | 11.293 | 731.5 | 8.2 |
| 477.4 | .788 | 11.554 | 682.5 | 8.6 |
| 517.4 | .864 | 11.688 | 644.3 | 9.2 |
| 606.8 | 1.310 | 15.113 | 404.7 | 8.4 |
| 722.3 | .914 | 8.858 | 826.6 | 17.0 |
| 845.5 | .988 | 8.180 | 860.9 | 21.5 |
| 1225.8 | 1.660 | 9.479 | 573.2 | 26.9 |
| 1697.1 | 1.430 | 5.898 | 992.4 | 59.8 |
| 2256.1 | 1.870 | 5.802 | 882.3 | 80.9 |
| 4258.1 | 2.220 | 3.650 | 1287.3 | 242.7 |
| 6905.4 | 4.700 | 4.764 | 677.7 | 301.5 |
| 317.2 | .571 | 12.599 | 735.2 | 5.2 |
| 354.2 | .718 | 14.190 | 582.2 | 5.2 |
| 388.1 | .682 | 12.302 | 689.0 | 6.6 |
| 425.0 | .648 | 10.672 | 814.8 | 8.3 |
| 489.7 | .711 | 10.163 | 816.9 | 10.0 |
| 517.4 | .800 | 10.823 | 723.1 | 9.9 |
| 597.5 | .831 | 9.735 | 788.8 | 12.8 |
| 834.7 | .947 | 7.942 | 905.7 | 21.9 |
| 890.1 | 1.160 | 9.122 | 712.5 | 20.3 |
| 1406.0 | 1.270 | 6.323 | 982.4 | 46.3 |
| 2651.9 | 2.300 | 6.071 | 760.3 | 90.9 |
| 315.7 | .714 | 15.831 | 523.3 | 4.1 |
| 355.7 | .601 | 11.826 | 761.5 | 6.3 |
| 358.8 | .715 | 13.948 | 593.5 | 5.4 |
| 435.8 | .564 | 9.059 | 1028.9 | 10.0 |
| 532.8 | .660 | 8.671 | 993.8 | 12.8 |
| 579.0 | .699 | 8.450 | 990.8 | 14.3 |
| 639.1 | 1.050 | 11.501 | 594.0 | 11.6 |
| 736.1 | .869 | 8.264 | 908.7 | 18.5 |
| 830.1 | 1.490 | 12.565 | 456.4 | 13.7 |
| 1145.8 | 1.380 | 8.431 | 706.8 | 28.3 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 2114.4 | 1.900 | 6.290 | 807.3 | 69.9 |
| 406.6 | .578 | 9.956 | 924.6 | 8.5 |
| 417.3 | .704 | 11.809 | 706.5 | 7.4 |
| 423.5 | .620 | 10.242 | 868.2 | 8.6 |
| 426.6 | .795 | 13.045 | 601.8 | 6.8 |
| 428.1 | .843 | 13.781 | 553.3 | 6.5 |
| 429.7 | .609 | 9.918 | 904.6 | 9.0 |
| 398.9 | .741 | 13.009 | 625.0 | 6.4 |
| 445.1 | .661 | 10.390 | 828.9 | 8.9 |
| 460.5 | .837 | 12.718 | 601.8 | 7.5 |
| 469.7 | .858 | 12.782 | 591.3 | 7.6 |
| 472.8 | .982 | 14.547 | 485.5 | 6.8 |
| 483.6 | .661 | 9.565 | 900.3 | 10.5 |
| 358.8 | .608 | 11.862 | 756.7 | 6.3 |
| 357.3 | .639 | 12.512 | 700.1 | 5.9 |
| 360.4 | .802 | 15.579 | 501.7 | 4.8 |
| 360.4 | .544 | 10.571 | 897.7 | 7.1 |
| 361.9 | .804 | 15.544 | 502.3 | 4.8 |
| 368.1 | .761 | 14.469 | 554.6 | 5.3 |
| 378.8 | .713 | 13.178 | 629.0 | 6.0 |
| 386.5 | .770 | 13.948 | 571.9 | 5.8 |
| 386.5 | .667 | 12.071 | 710.2 | 6.7 |
| 392.7 | .729 | 12.988 | 631.4 | 6.3 |
| 392.7 | .753 | 13.430 | 600.5 | 6.1 |
| 405.0 | .706 | 12.203 | 682.7 | 6.9 |
| 311.1 | .646 | 14.526 | 509.8 | 4.5 |
| 314.2 | .576 | 12.828 | 719.2 | 5.1 |
| 320.4 | .558 | 12.074 | 776.3 | 5.6 |
| 324.9 | .688 | 14.823 | 569.3 | 4.6 |
| 324.9 | .616 | 13.276 | 671.6 | 5.3 |
| 326.5 | .593 | 12.707 | 719.6 | 5.3 |
| 329.6 | .492 | 10.448 | 955.3 | 6.6 |
| 334.2 | .723 | 15.145 | 543.6 | 4.6 |
| 346.5 | .524 | 10.590 | 913.0 | 6.8 |
| 346.5 | .654 | 13.220 | 654.5 | 5.5 |
| 351.1 | .441 | 8.790 | 1199.4 | 8.3 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 351.1 | .591 | 11.783 | 772.7 | 6.2 |
| 485.1 | .789 | 11.392 | 691.5 | 8.9 |
| 497.4 | .971 | 13.668 | 519.7 | 7.6 |
| 499.0 | .779 | 10.933 | 725.3 | 9.5 |
| 502.0 | .833 | 11.608 | 660.9 | 9.0 |
| 503.6 | .911 | 12.658 | 579.5 | 8.3 |
| 505.1 | .771 | 10.691 | 745.4 | 9.8 |
| 523.6 | .954 | 12.751 | 562.1 | 8.5 |
| 542.1 | .822 | 10.615 | 727.3 | 10.6 |
| 568.3 | 1.062 | 13.086 | 519.0 | 9.0 |
| 571.3 | 1.009 | 12.363 | 563.7 | 9.6 |
| 582.1 | .900 | 10.825 | 681.6 | 11.2 |
| 592.9 | .932 | 11.008 | 658.5 | 11.2 |
| 600.6 | .780 | 9.096 | 871.2 | 13.7 |
| 608.3 | 1.001 | 11.515 | 607.7 | 11.0 |
| 609.8 | 1.145 | 13.144 | 497.7 | 9.7 |
| 637.6 | 1.209 | 13.274 | 479.6 | 10.0 |
| 637.6 | .884 | 9.711 | 766.4 | 13.7 |
| 702.2 | .761 | 7.587 | 1057.5 | 19.3 |
| 648.3 | 1.063 | 11.478 | 591.5 | 11.7 |
| 673.0 | 1.229 | 12.782 | 494.0 | 11.0 |
| 703.8 | .807 | 8.030 | 970.1 | 18.2 |
| 705.3 | 1.681 | 16.685 | 323.6 | 8.8 |
| 720.7 | 1.150 | 11.174 | 584.1 | 13.4 |
| 740.7 | .979 | 9.252 | 764.6 | 16.7 |
| 751.5 | 1.229 | 11.444 | 551.9 | 13.7 |
| 777.7 | 1.087 | 9.788 | 685.8 | 16.5 |
| 817.7 | 1.060 | 9.076 | 749.0 | 18.7 |
| 822.4 | 1.313 | 11.179 | 546.4 | 15.3 |
| 857.8 | 1.377 | 11.234 | 531.1 | 15.9 |
| 896.3 | .994 | 7.767 | 903.7 | 24.0 |
| 910.1 | 1.454 | 11.182 | 519.2 | 16.9 |
| 927.1 | 1.134 | 8.561 | 767.8 | 22.5 |
| 956.3 | 1.224 | 8.963 | 705.8 | 22.2 |
| 994.8 | 1.297 | 9.124 | 673.8 | 22.7 |
| 751.5 | 1.229 | 11.444 | 551.9 | 13.7 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 308.0 | .663 | 15.059 | 571.0 | 4.3 |
| 777.7 | 1.087 | 9.788 | 685.8 | 16.5 |
| 817.7 | 1.060 | 9.076 | 749.0 | 18.7 |
| 822.4 | 1.313 | 11.179 | 546.4 | 15.3 |
| 857.8 | 1.377 | 11.234 | 531.1 | 15.9 |
| 896.3 | .994 | 7.767 | 903.7 | 24.0 |
| 910.1 | 1.454 | 11.182 | 519.2 | 16.9 |
| 927.1 | 1.134 | 8.561 | 767.8 | 22.5 |
| 956.3 | 1.224 | 8.963 | 705.8 | 22.2 |
| 994.8 | 1.297 | 9.124 | 673.8 | 22.7 |
| 922.5 | 1.687 | 12.798 | 421.2 | 15.0 |
| 317.2 | .553 | 12.201 | 771.5 | 5.4 |
| 378.8 | .654 | 12.078 | 716.9 | 6.5 |
| 477.4 | .693 | 10.163 | 827.3 | 9.8 |
| 509.7 | .663 | 9.104 | 944.3 | 11.6 |
| 580.6 | .859 | 10.360 | 728.9 | 11.7 |
| 671.4 | .952 | 9.921 | 723.3 | 14.1 |
| 768.5 | 1.239 | 11.286 | 557.2 | 14.2 |
| 782.3 | .887 | 7.933 | 937.2 | 20.5 |
| 807.0 | 1.247 | 10.814 | 579.8 | 15.5 |
| 833.1 | .911 | 7.654 | 958.2 | 22.6 |
| 959.4 | 1.088 | 7.939 | 845.3 | 25.1 |
| 1104.2 | 1.203 | 7.628 | 836.6 | 30.1 |
| 401.9 | .680 | 11.834 | 717.6 | 7.1 |

Total number of fragments = 132

Average ballistic density for all fragments = 710.1

Average gamma for all fragments = 10.997

Number of hazardous fragments in zone = 6

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION

Location: White Sands Missile Range, NM

Date: 23 January 1980

Collection Zone: Azimuth: 0-20°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | No. Fragment |
|---|---|
| 0 - 300 | 1694 |
| 300 - 770 | 400 |
| 770 - 1080 | 182 |
| 1080 - 1540 | 141 |
| 1540 - 2310 | 94 |
| 2310 - 3080 | 63 |
| 3080+ | 50 |

Collection Zone: Azimuth: 70-80°
Range: 500 to 700 ft

| Fragment Wt. (gr) | No. Fragment |
|---|---|
| 0 - 300 | 2654 |
| 300 - 770 | 437 |
| 770 - 1080 | 154 |
| 1080 - 1540 | 91 |
| 1540 - 2310 | 63 |
| 2310 - 3080 | 33 |
| 3080+ | 18 |

Collection Zone: Azimuth: 80-90°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | No. Fragment |
|---|---|
| 0 - 300 | 2944 |
| 300 - 770 | 475 |
| 770 - 1080 | 184 |
| 1080 - 1540 | 120 |
| 1540 - 2310 | 84 |
| 2310 - 3080 | 50 |
| 3080+ | 40 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

Collection Zone: Azimuth: 90-100°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | No. Fragment |
|---|---|
| 0 - 300 | 2620 |
| 300 - 770 | 552 |
| 770 - 1080 | 238 |
| 1080 - 1540 | 163 |
| 1540 - 2310 | 113 |
| 2310 - 3080 | 66 |
| 3080+ | 40 |

Collection Zone: Azimuth: 100-110°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | No. Fragment |
|---|---|
| 0 - 300 | 2220 |
| 300 - 770 | 382 |
| 770 - 1080 | 173 |
| 1080 - 1540 | 117 |
| 1540 - 2310 | 89 |
| 2310 - 3080 | 52 |
| 3080+ | 40 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 797.72 | 1.20 | 10.5 | 605.6 | 15.7 |
| 1151.92 | 1.86 | 11.3 | 453.3 | 21.2 |
| 1047.20 | 1.71 | 11.4 | 469.3 | 19.1 |
| 816.20 | 1.00 | 8.6 | 815.6 | 19.8 |
| 834.68 | 1.12 | 9.4 | 705.1 | 18.5 |
| 845.46 | 1.21 | 10.0 | 632.9 | 17.5 |
| 870.10 | 1.22 | 9.8 | 643.0 | 18.4 |
| 887.04 | 1.21 | 9.6 | 662.5 | 19.2 |
| 897.82 | 1.12 | 8.7 | 761.6 | 21.5 |
| 900.90 | 1.01 | 7.9 | 882.8 | 23.8 |
| 922.46 | .95 | 7.2 | 1003.0 | 26.7 |
| 982.52 | 1.03 | 7.3 | 946.0 | 28.0 |
| 1033.34 | 1.48 | 10.0 | 573.3 | 21.4 |
| 1050.28 | 1.70 | 11.4 | 472.1 | 19.2 |
| 1147.30 | 1.39 | 8.5 | 703.2 | 28.2 |
| 1171.94 | 1.43 | 8.6 | 683.3 | 28.5 |
| 1188.88 | 1.75 | 10.3 | 514.1 | 24.0 |
| 1211.98 | 1.62 | 9.4 | 586.6 | 26.9 |
| 1284.36 | 1.68 | 9.1 | 592.5 | 29.3 |
| 1333.64 | 2.06 | 10.8 | 451.6 | 25.7 |
| 1338.26 | 1.61 | 8.4 | 652.5 | 33.0 |
| 1569.26 | 1.64 | 7.3 | 746.0 | 44.6 |
| 1649.34 | 1.87 | 7.9 | 646.7 | 43.3 |
| 1684.76 | 2.23 | 9.3 | 504.8 | 37.8 |
| 1695.54 | 2.25 | 9.3 | 502.4 | 38.0 |
| 1703.24 | 1.73 | 7.1 | 746.4 | 49.7 |
| 1801.80 | 2.08 | 8.1 | 602.8 | 46.5 |
| 1815.66 | 1.77 | 6.8 | 773.2 | 55.4 |
| 1895.74 | 2.29 | 8.5 | 546.5 | 46.6 |
| 1903.44 | 2.13 | 7.8 | 610.9 | 50.5 |
| 2102.10 | 2.48 | 8.2 | 539.9 | 53.1 |
| 2169.86 | 2.25 | 7.3 | 642.9 | 62.2 |
| 2373.14 | 2.59 | 7.6 | 568.8 | 64.6 |
| 2376.22 | 2.52 | 7.4 | 595.2 | 66.7 |
| 2427.04 | 2.48 | 7.1 | 623.3 | 70.7 |
| 2670.36 | 3.28 | 8.6 | 450.6 | 64.7 |
| 3163.16 | 2.48 | 5.5 | 808.3 | 119.7 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 3224.76 | 3.68 | 8.0 | 456.2 | 83.9 |
| 3226.30 | 3.32 | 7.2 | 534.1 | 93.3 |
| 3538.92 | 3.40 | 6.7 | 564.5 | 109.5 |
| 3854.62 | 3.60 | 6.5 | 564.3 | 122.6 |
| 3916.22 | 3.68 | 6.6 | 554.0 | 123.7 |
| 4053.28 | 4.26 | 7.4 | 461.3 | 114.6 |
| 5243.70 | 3.63 | 4.8 | 759.8 | 225.4 |
| 6432.58 | 3.68 | 4.0 | 913.1 | 334.6 |
| 8180.48 | 4.58 | 3.9 | 833.7 | 433.9 |
| 8808.80 | 6.73 | 5.4 | 504.2 | 342.4 |
| 11745.58 | 8.68 | 5.2 | 459.7 | 472.5 |
| 803.88 | 1.05 | 9.2 | 742.4 | 18.2 |
| 834.68 | 1.01 | 8.4 | 827.3 | 20.6 |
| 1071.84 | 2.04 | 13.3 | 366.8 | 16.7 |
| 848.54 | .97 | 8.0 | 889.5 | 22.1 |
| 902.44 | 1.28 | 10.0 | 620.9 | 18.9 |
| 964.04 | 1.20 | 8.7 | 733.9 | 23.0 |
| 1185.80 | 1.25 | 7.4 | 852.2 | 33.5 |
| 1273.58 | 1.47 | 8.1 | 717.0 | 32.9 |
| 1296.68 | 1.73 | 9.3 | 572.3 | 29.0 |
| 1569.26 | 1.87 | 8.3 | 615.3 | 39.2 |
| 1720.18 | 2.19 | 8.9 | 530.2 | 40.1 |
| 1932.70 | 2.33 | 8.4 | 545.2 | 47.7 |
| 2095.94 | 2.08 | 6.9 | 701.2 | 62.9 |
| 2169.86 | 2.37 | 7.6 | 596.0 | 59.1 |
| 2249.94 | 2.65 | 8.2 | 521.6 | 56.8 |
| 2427.04 | 2.80 | 8.1 | 518.0 | 62.5 |
| 2448.60 | 2.25 | 6.4 | 725.5 | 9.2 |
| 2616.46 | 2.43 | 6.5 | 692.9 | 83.9 |
| 3012.24 | 2.62 | 6.1 | 711.7 | 103.0 |
| 3075.38 | 3.26 | 7.4 | 522.9 | 86.3 |
| 3398.78 | 3.49 | 7.2 | 520.9 | 98.3 |
| 3788.40 | 2.96 | 5.5 | 744.5 | 144.2 |
| 3883.88 | 3.54 | 6.4 | 582.7 | 126.6 |
| 5383.84 | 3.33 | 4.3 | 884.7 | 258.4 |
| 5453.14 | 4.44 | 5.7 | 582.5 | 198.9 |
| 6432.58 | 3.99 | 4.3 | 806.6 | 308.0 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 7760.06 | 4.33 | 3.9 | 862.8 | 413.7 |
| 11745.58 | 7.64 | 4.6 | 556.0 | 536.4 |
| 14192.64 | 10.07 | 5.0 | 444.4 | 594.6 |
| 1039.50 | 1.31 | 8.8 | 693.3 | 24.5 |
| 1288.98 | 1.53 | 8.3 | 678.9 | 32.2 |
| 2279.20 | 2.28 | 7.0 | 660.6 | 67.6 |
| 4781.70 | 2.91 | 4.3 | 964.1 | 233.6 |
| 9369.36 | 6.95 | 5.2 | 511.4 | 375.3 |

Total number of fragments = 82

Average ballistic density for all fragments = 644.1

Average gamma for all fragments = 7.726

Number of hazardous fragments in zone = 36

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 309.5 | .538 | 12.166 | 784.4 | 5.3 |
| 317.2 | .529 | 11.673 | 824.5 | 5.7 |
| 328.0 | .519 | 11.076 | 877.3 | 6.2 |
| 334.2 | .734 | 15.375 | 531.4 | 4.5 |
| 335.7 | .501 | 10.446 | 946.7 | 6.7 |
| 337.3 | .749 | 15.546 | 520.3 | 4.5 |
| 340.3 | .604 | 12.423 | 725.0 | 5.7 |
| 346.5 | .797 | 16.101 | 487.0 | 4.5 |
| 354.2 | .622 | 12.292 | 722.0 | 6.0 |
| 361.9 | .638 | 12.340 | 710.2 | 6.1 |
| 369.6 | .567 | 10.739 | 865.7 | 7.2 |
| 375.8 | .864 | 16.095 | 467.9 | 4.9 |
| 378.8 | .602 | 11.123 | 811.1 | 7.1 |
| 383.5 | .535 | 9.766 | 979.9 | 8.2 |
| 386.5 | .623 | 11.282 | 786.1 | 7.1 |
| 389.6 | .622 | 11.175 | 794.2 | 7.3 |
| 391.2 | .610 | 10.916 | 821.0 | 7.5 |
| 401.9 | .838 | 14.594 | 524.0 | 5.7 |
| 415.8 | .996 | 16.768 | 418.3 | 5.2 |
| 420.4 | .706 | 11.755 | 708.7 | 7.4 |
| 420.4 | .675 | 11.239 | 758.1 | 7.8 |
| 438.9 | 1.180 | 18.820 | 342.4 | 4.9 |
| 460.5 | .783 | 11.903 | 664.6 | 8.0 |
| 462.0 | .657 | 9.955 | 867.5 | 9.7 |
| 482.0 | .739 | 10.732 | 758.7 | 9.3 |
| 482.0 | .707 | 10.267 | 810.8 | 9.8 |
| 483.6 | .827 | 11.972 | 643.0 | 8.4 |
| 483.6 | .765 | 10.074 | 722.7 | 9.1 |
| 519.0 | .754 | 10.170 | 792.7 | 10.6 |
| 525.1 | .740 | 9.637 | 854.2 | 11.3 |
| 531.3 | .881 | 9.750 | 834.6 | 11.3 |
| 537.5 | .731 | 11.474 | 650.0 | 9.7 |
| 537.5 | 1.200 | 9.521 | 859.9 | 11.7 |
| 540.5 | .779 | 15.540 | 411.2 | 7.2 |
| 551.3 | .779 | 9.891 | 801.9 | 11.6 |
| 592.9 | .946 | 9.197 | 862.3 | 13.4 |
| 599.1 | .854 | 11.054 | 651.1 | 11.3 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 619.1 | .854 | 9.656 | 784.4 | 13.3 |
| 636.0 | 1.300 | 14.308 | 429.1 | 9.2 |
| 677.6 | 1.130 | 11.674 | 564.1 | 12.1 |
| 679.1 | 1.470 | 15.152 | 381.1 | 9.3 |
| 714.6 | .898 | 8.797 | 839.7 | 16.9 |
| 717.6 | .987 | 9.627 | 731.9 | 15.5 |
| 750.0 | 1.060 | 9.894 | 687.2 | 15.8 |
| 753.1 | 1.240 | 11.526 | 545.4 | 15.6 |
| 794.6 | 1.010 | 8.897 | 782.9 | 18.6 |
| 820.8 | 1.450 | 12.366 | 470.1 | 13.8 |
| 830.1 | 1.170 | 9.867 | 655.9 | 17.5 |
| 856.2 | 1.160 | 9.483 | 685.3 | 18.8 |
| 860.9 | 1.170 | 9.514 | 608.2 | 18.8 |
| 900.9 | 1.150 | 8.936 | 730.5 | 21.0 |
| 2005.1 | 2.140 | 7.471 | 640.5 | 55.8 |
| 1181.2 | 1.270 | 7.526 | 825.3 | 32.6 |
| 1290.5 | 1.260 | 6.834 | 912.4 | 39.3 |
| 1647.8 | 1.380 | 5.862 | 1016.4 | 58.5 |
| 2875.2 | 1.950 | 4.748 | 1055.9 | 126.0 |
| 6012.2 | 4.910 | 5.717 | 552.6 | 218.7 |
| 6851.5 | 4.840 | 4.945 | 643.5 | 288.2 |
| 309.5 | .480 | 10.855 | 930.8 | 5.9 |
| 317.2 | .477 | 10.525 | 963.0 | 6.3 |
| 318.8 | .584 | 12.824 | 714.3 | 5.2 |
| 323.4 | .506 | 10.952 | 898.5 | 6.1 |
| 324.9 | .539 | 11.611 | 821.1 | 5.8 |
| 335.7 | .715 | 14.908 | 555.3 | 4.7 |
| 340.3 | .756 | 15.549 | 517.8 | 4.6 |
| 341.9 | .604 | 12.367 | 728.3 | 5.8 |
| 343.4 | .675 | 13.759 | 619.3 | 5.2 |
| 345.0 | .801 | 16.254 | 481.2 | 4.4 |
| 354.2 | .592 | 11.700 | 777.6 | 6.3 |
| 357.3 | .554 | 10.854 | 866.5 | 6.8 |
| 363.4 | .748 | 14.407 | 561.8 | 5.2 |
| 369.6 | .563 | 10.663 | 874.9 | 7.2 |
| 389.6 | .645 | 11.588 | 752.1 | 7.0 |
| 418.9 | .691 | 11.547 | 729.2 | 7.5 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 420.4 | .621 | 10.340 | 859.1 | 8.5 |
| 435.8 | .735 | 11.805 | 691.6 | 7.7 |
| 438.9 | 1.160 | 18.501 | 351.3 | 4.9 |
| 457.4 | .923 | 14.126 | 515.8 | 6.7 |
| 465.1 | .809 | 12.176 | 639.2 | 7.9 |
| 466.6 | .707 | 10.606 | 784.9 | 9.2 |
| 477.4 | 1.060 | 15.543 | 437.4 | 6.4 |
| 478.9 | .716 | 10.465 | 790.5 | 9.5 |
| 483.6 | .828 | 11.986 | 641.8 | 8.4 |
| 485.1 | .745 | 10.750 | 754.4 | 9.4 |
| 486.6 | .748 | 10.759 | 752.2 | 9.4 |
| 488.2 | .730 | 10.467 | 782.7 | 9.7 |
| 489.7 | .814 | 11.635 | 666.8 | 8.8 |
| 495.9 | .827 | 11.674 | 659.4 | 8.8 |
| 497.4 | .667 | 9.386 | 913.1 | 11.0 |
| 506.7 | .626 | 8.649 | 1023.0 | 12.2 |
| 526.7 | .797 | 10.593 | 740.2 | 10.3 |
| 535.9 | .798 | 10.423 | 751.8 | 10.7 |
| 535.9 | .777 | 10.149 | 782.5 | 11.0 |
| 546.7 | 1.410 | 18.054 | 326.5 | 6.3 |
| 548.2 | .722 | 9.219 | 893.6 | 12.4 |
| 551.3 | .769 | 9.764 | 817.5 | 11.7 |
| 566.7 | 1.190 | 14.699 | 436.6 | 8.0 |
| 586.7 | 1.460 | 17.418 | 332.6 | 7.0 |
| 597.5 | .845 | 9.899 | 769.2 | 12.6 |
| 611.4 | .735 | 8.415 | 970.2 | 15.1 |
| 622.2 | .893 | 10.047 | 737.3 | 12.9 |
| 626.8 | .911 | 10.174 | 720.8 | 12.8 |
| 626.8 | 1.400 | 15.635 | 378.4 | 8.3 |
| 639.1 | .804 | 8.806 | 886.5 | 15.1 |
| 651.4 | .928 | 9.972 | 728.7 | 13.6 |
| 656.0 | 1.180 | 12.591 | 511.8 | 10.8 |
| 665.3 | .953 | 10.027 | 715.1 | 13.8 |
| 686.8 | 1.100 | 11.211 | 595.3 | 12.7 |
| 731.5 | 1.340 | 12.823 | 471.6 | 11.9 |
| 734.6 | 1.100 | 10.482 | 636.7 | 14.6 |
| 745.4 | .901 | 8.462 | 871.5 | 18.3 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 745.4 | .839 | 7.879 | 969.9 | 19.7 |
| 760.8 | .943 | 8.677 | 830.8 | 18.2 |
| 782.3 | .952 | 8.518 | 842.2 | 19.1 |
| 820.8 | 1.010 | 8.613 | 808.7 | 19.8 |
| 842.4 | 1.670 | 13.877 | 390.3 | 12.6 |
| 848.5 | 1.010 | 8.332 | 836.0 | 21.2 |
| 874.7 | 1.280 | 10.243 | 604.0 | 17.8 |
| 922.5 | 1.220 | 9.258 | 684.6 | 20.7 |
| 922.5 | 1.090 | 8.271 | 810.6 | 23.2 |
| 961.0 | 1.260 | 9.178 | 679.4 | 21.8 |
| 987.1 | 1.790 | 12.693 | 412.2 | 16.2 |
| 1025.6 | 2.090 | 14.264 | 339.4 | 15.0 |
| 1054.9 | 1.240 | 8.228 | 764.0 | 26.7 |
| 1070.3 | 1.010 | 6.606 | 1054.4 | 33.7 |
| 1084.2 | 1.390 | 8.975 | 661.6 | 25.1 |
| 1284.4 | 1.330 | 7.249 | 837.4 | 36.9 |
| 1406.0 | 1.480 | 7.368 | 780.9 | 39.7 |
| 1660.1 | 1.720 | 7.252 | 735.9 | 47.6 |
| 1638.2 | 2.030 | 8.442 | 582.0 | 41.5 |
| 1758.7 | 2.110 | 8.398 | 573.8 | 43.6 |
| 1960.4 | 2.080 | 7.427 | 653.5 | 54.9 |
| 2108.3 | 1.950 | 6.475 | 774.2 | 67.7 |
| 2462.5 | 2.360 | 6.709 | 679.2 | 76.3 |
| 7760.1 | 5.830 | 5.259 | 551.3 | 306.9 |
| 10696.8 | 5.200 | 3.403 | 902.1 | 653.8 |
| 1279.7 | 1.620 | 8.861 | 620.7 | 30.0 |
| 1436.8 | 1.570 | 7.649 | 730.4 | 39.1 |
| 1466.1 | 2.210 | 10.552 | 446.2 | 28.9 |
| 1546.2 | 1.330 | 6.021 | 1008.0 | 53.4 |
| 1553.9 | 1.490 | 6.712 | 854.3 | 48.2 |
| 1607.8 | 1.910 | 8.316 | 609.1 | 40.2 |
| 1674.0 | 1.830 | 7.652 | 676.2 | 45.4 |
| 1726.3 | 1.490 | 6.042 | 949.2 | 59.4 |
| 1732.5 | 1.990 | 8.040 | 617.2 | 44.8 |
| 2565.6 | 2.470 | 6.739 | 660.9 | 79.2 |
| 312.6 | .597 | 13.368 | 677.7 | 4.9 |
| 315.7 | .507 | 11.242 | 874.5 | 5.8 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 315.7 | .582 | 12.905 | 711.0 | 5.1 |
| 317.2 | .507 | 11.187 | 878.8 | 5.9 |
| 321.9 | .678 | 14.746 | 576.5 | 4.5 |
| 323.4 | .703 | 15.216 | 548.7 | 4.4 |
| 323.4 | .603 | 13.052 | 690.7 | 5.2 |
| 329.6 | .537 | 11.406 | 837.5 | 6.0 |
| 334.2 | .562 | 11.772 | 793.2 | 5.9 |
| 334.2 | .636 | 13.322 | 658.9 | 5.2 |
| 338.8 | .720 | 14.876 | 554.6 | 4.7 |
| 341.9 | .646 | 13.227 | 658.5 | 5.4 |
| 341.9 | .577 | 11.814 | 780.0 | 6.0 |
| 343.4 | .631 | 12.862 | 685.1 | 5.6 |
| 351.1 | .608 | 12.121 | 740.6 | 6.0 |
| 354.2 | .563 | 11.126 | 838.5 | 6.6 |
| 354.2 | .778 | 15.375 | 516.2 | 4.8 |
| 358.8 | .627 | 12.232 | 722.7 | 6.1 |
| 375.8 | .578 | 10.768 | 855.1 | 7.3 |
| 380.4 | .528 | 9.717 | 991.4 | 8.1 |
| 381.9 | .562 | 10.301 | 906.5 | 7.7 |
| 386.5 | .790 | 14.306 | 550.5 | 5.6 |
| 388.1 | .666 | 12.013 | 714.0 | 6.7 |
| 405.0 | .696 | 12.029 | 697.5 | 7.0 |
| 417.3 | .470 | 7.883 | 1295.2 | 11.0 |
| 423.5 | .747 | 12.347 | 656.0 | 7.1 |
| 429.7 | .847 | 13.799 | 551.2 | 6.5 |
| 434.3 | .839 | 13.524 | 565.1 | 6.7 |
| 454.3 | .698 | 10.755 | 779.0 | 8.8 |
| 471.2 | .671 | 9.967 | 857.4 | 9.8 |
| 523.6 | .858 | 11.471 | 658.8 | 9.5 |
| 532.8 | .728 | 9.564 | 857.8 | 11.6 |
| 534.4 | .889 | 11.645 | 637.5 | 9.5 |
| 551.3 | .560 | 7.110 | 1315.6 | 16.1 |
| 562.1 | .735 | 9.153 | 892.0 | 12.8 |
| 592.9 | .819 | 9.669 | 799.9 | 12.8 |
| 594.4 | .888 | 10.457 | 710.4 | 11.8 |
| 612.9 | .748 | 8.543 | 947.4 | 14.9 |
| 631.4 | .585 | 6.486 | 1411.1 | 20.2 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 631.4 | .768 | 8.514 | 938.1 | 15.4 |
| 637.6 | 1.050 | 11.528 | 592.6 | 11.5 |
| 685.3 | 1.010 | 10.317 | 675.1 | 13.8 |
| 694.5 | 1.120 | 11.288 | 586.0 | 12.8 |
| 706.9 | 1.080 | 10.695 | 629.8 | 13.7 |
| 730.0 | .971 | 9.311 | 762.9 | 16.3 |
| 739.2 | 1.110 | 10.511 | 632.1 | 14.6 |
| 766.9 | .931 | 8.498 | 853.7 | 18.8 |
| 783.9 | 1.270 | 11.341 | 547.7 | 14.4 |
| 786.9 | 1.160 | 10.318 | 629.9 | 15.9 |
| 790.0 | 1.090 | 9.658 | 694.2 | 17.0 |
| 797.7 | .975 | 8.556 | 828.6 | 19.4 |
| 810.0 | .714 | 6.170 | 1342.6 | 27.3 |
| 811.6 | 1.130 | 9.746 | 675.6 | 17.3 |
| 816.2 | .928 | 7.959 | 913.0 | 21.3 |
| 820.8 | .704 | 6.004 | 1389.6 | 28.4 |
| 880.9 | .644 | 5.118 | 1704.5 | 35.8 |
| 880.9 | 1.080 | 8.582 | 784.8 | 21.3 |
| 882.4 | 1.180 | 9.361 | 688.4 | 19.6 |
| 286.4 | .646 | 15.787 | 551.7 | 3.8 |
| 301.8 | .506 | 11.735 | 838.6 | 5.4 |
| 309.5 | .486 | 10.991 | 913.6 | 5.9 |
| 311.1 | .529 | 11.904 | 808.5 | 5.4 |
| 314.2 | .504 | 11.230 | 878.0 | 5.8 |
| 315.7 | .533 | 11.818 | 811.3 | 5.6 |
| 321.9 | .575 | 12.505 | 738.2 | 5.4 |
| 321.9 | .675 | 14.680 | 580.4 | 4.6 |
| 326.5 | .545 | 11.685 | 811.5 | 5.8 |
| 334.2 | .643 | 13.469 | 648.1 | 5.2 |
| 343.4 | .674 | 13.738 | 620.6 | 5.2 |
| 346.5 | .698 | 14.101 | 594.2 | 5.1 |
| 346.5 | .630 | 12.727 | 692.9 | 5.7 |
| 348.0 | .596 | 11.987 | 756.4 | 6.0 |
| 354.2 | .622 | 12.292 | 722.0 | 6.0 |
| 357.3 | .583 | 11.422 | 802.6 | 6.5 |
| 363.4 | .600 | 11.556 | 782.0 | 6.5 |
| 363.4 | .730 | 14.060 | 582.7 | 5.4 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 368.1 | .531 | 10.099 | 951.2 | 7.6 |
| 372.7 | .533 | 10.011 | 957.7 | 7.7 |
| 375.8 | .773 | 14.400 | 552.9 | 5.4 |
| 375.8 | .590 | 10.991 | 829.1 | 7.1 |
| 375.8 | .565 | 10.525 | 884.8 | 7.4 |
| 378.8 | .560 | 10.347 | 904.0 | 7.6 |
| 378.8 | .650 | 12.010 | 722.9 | 6.6 |
| 380.4 | .509 | 9.367 | 1047.5 | 8.4 |
| 381.9 | .681 | 12.482 | 679.6 | 6.4 |
| 383.5 | .703 | 12.833 | 650.6 | 6.2 |
| 389.6 | .575 | 10.331 | 893.6 | 7.8 |
| 397.3 | .815 | 14.359 | 540.0 | 5.8 |
| 401.9 | .773 | 13.462 | 591.4 | 6.2 |
| 405.0 | .726 | 12.548 | 654.7 | 6.7 |
| 408.1 | .749 | 12.847 | 629.6 | 6.6 |
| 412.7 | .650 | 11.024 | 787.6 | 7.8 |
| 412.7 | .817 | 13.857 | 558.9 | 6.2 |
| 412.7 | .653 | 11.075 | 782.1 | 7.8 |
| 414.3 | .656 | 11.085 | 779.7 | 7.8 |
| 417.3 | .706 | 11.842 | 703.5 | 7.3 |
| 422.0 | .808 | 13.404 | 531.0 | 6.5 |
| 422.0 | .720 | 11.944 | 590.7 | 7.0 |
| 422.0 | .701 | 11.629 | 718.9 | 7.5 |
| 429.7 | .844 | 13.750 | 554.1 | 6.5 |
| 434.3 | .889 | 14.329 | 518.1 | 6.3 |
| 437.4 | .760 | 12.164 | 660.1 | 7.5 |
| 438.9 | .685 | 10.925 | 774.2 | 8.4 |
| 438.9 | .744 | 11.866 | 683.9 | 7.7 |
| 440.4 | .730 | 11.602 | 706.2 | 7.9 |
| 443.5 | .684 | 10.795 | 784.0 | 8.5 |
| 446.6 | .698 | 10.940 | 769.8 | 8.5 |
| 457.4 | .915 | 14.004 | 522.6 | 6.9 |
| 466.6 | .779 | 11.686 | 678.7 | 8.3 |
| 469.7 | .908 | 13.532 | 542.9 | 7.2 |
| 469.7 | .688 | 10.2[illegible] | 823.1 | 9.5 |
| 472.8 | .713 | 10.5[illegible] | 785.3 | 9.3 |
| 485.1 | .723 | 10.433 | 789.1 | 9.7 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 485.1 | .759 | 10.952 | 733.6 | 9.2 |
| 488.2 | .869 | 12.461 | 602.6 | 8.1 |
| 492.8 | .667 | 9.474 | 904.7 | 10.8 |
| 514.4 | .908 | 12.357 | 594.5 | 8.7 |
| 515.9 | .910 | 12.347 | 594.3 | 8.7 |
| 515.9 | .868 | 11.777 | 637.9 | 9.1 |
| 520.5 | .750 | 10.086 | 801.4 | 10.7 |
| 522.1 | .671 | 8.997 | 949.8 | 12.1 |
| 543.6 | .984 | 12.671 | 556.9 | 8.9 |
| 554.4 | .771 | 9.735 | 818.9 | 11.8 |
| 576.0 | .883 | 10.732 | 694.1 | 11.2 |
| 579.0 | .859 | 10.384 | 727.3 | 11.6 |
| 580.6 | .988 | 11.912 | 591.2 | 10.1 |
| 582.1 | .928 | 11.159 | 651.2 | 10.9 |
| 583.7 | .916 | 10.986 | 665.8 | 11.1 |
| 589.8 | .893 | 10.598 | 698.9 | 11.6 |
| 596.0 | .799 | 9.385 | 834.5 | 13.2 |
| 597.5 | 1.060 | 12.418 | 547.5 | 10.0 |
| 600.6 | .910 | 10.606 | 691.9 | 11.8 |
| 603.7 | .955 | 11.074 | 646.8 | 11.3 |
| 609.8 | .978 | 11.226 | 630.5 | 11.3 |
| 622.2 | 1.460 | 16.427 | 352.7 | 7.9 |
| 625.2 | .813 | 9.102 | 852.9 | 14.3 |
| 625.2 | .966 | 10.815 | 658.5 | 12.0 |
| 632.9 | .880 | 9.732 | 766.7 | 13.5 |
| 634.5 | .855 | 9.433 | 802.5 | 14.0 |
| 653.0 | .939 | 10.066 | 717.6 | 13.5 |
| 662.2 | .873 | 9.228 | 811.8 | 14.9 |
| 679.1 | 1.110 | 11.441 | 580.7 | 12.3 |
| 686.8 | 1.470 | 14.982 | 385.4 | 9.5 |
| 697.6 | .869 | 8.720 | 861.2 | 16.6 |
| 702.2 | .926 | 9.230 | 788.1 | 15.8 |
| 709.9 | 1.200 | 11.832 | 540.1 | 12.5 |
| 709.9 | .939 | 9.259 | 780.2 | 15.9 |
| 717.6 | 1.090 | 10.632 | 630.6 | 14.0 |
| 720.7 | .868 | 8.430 | 891.2 | 17.8 |
| 737.7 | 1.110 | 10.533 | 630.8 | 14.6 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 737.7 | 1.040 | 9.869 | 695.5 | 15.5 |
| 768.5 | .894 | 8.144 | 909.1 | 19.6 |
| 770.0 | 1.340 | 12.182 | 496.4 | 13.1 |
| 776.2 | 1.025 | 9.247 | 747.6 | 17.5 |
| 951.7 | 1.580 | 11.623 | 479.1 | 17.0 |
| 783.9 | 1.008 | 9.005 | 774.2 | 18.1 |
| 785.4 | 1.134 | 10.109 | 650.1 | 16.2 |
| 785.4 | 1.390 | 12.387 | 479.3 | 13.2 |
| 796.2 | 1.061 | 9.330 | 728.3 | 17.7 |
| 803.9 | 1.013 | 8.821 | 788.5 | 19.0 |
| 803.9 | 1.043 | 9.083 | 754.6 | 18.4 |
| 816.2 | 1.039 | 8.912 | 770.5 | 19.0 |
| 825.4 | 1.063 | 9.019 | 752.6 | 19.0 |
| 836.2 | 1.043 | 8.732 | 784.9 | 19.9 |
| 847.0 | 1.521 | 12.574 | 451.3 | 14.0 |
| 882.4 | 1.128 | 8.952 | 736.1 | 20.5 |
| 884.0 | 1.229 | 9.731 | 648.9 | 18.9 |
| 890.1 | 1.110 | 8.730 | 761.0 | 21.2 |
| 919.4 | 1.431 | 10.894 | 537.2 | 17.6 |
| 928.6 | 1.544 | 11.638 | 484.1 | 16.6 |
| 931.7 | 1.257 | 9.441 | 661.5 | 20.5 |
| 953.3 | 1.179 | 8.656 | 744.9 | 22.9 |
| 954.8 | 1.318 | 9.660 | 631.3 | 20.6 |
| 1027.2 | 1.520 | 10.360 | 548.0 | 20.6 |
| 1045.7 | 1.147 | 7.679 | 851.1 | 28.3 |
| 1058.0 | 1.318 | 8.717 | 699.6 | 25.2 |
| 1125.7 | 1.606 | 9.984 | 553.3 | 23.5 |
| 1127.3 | 1.246 | 7.734 | 811.0 | 30.3 |
| 1199.7 | 1.528 | 8.916 | 635.1 | 28.0 |
| 1247.4 | 1.417 | 7.950 | 739.8 | 32.6 |
| 1250.5 | 2.058 | 11.522 | 423.5 | 22.6 |
| 1281.3 | 1.533 | 8.377 | 674.8 | 31.8 |
| 1301.3 | 1.675 | 9.010 | 600.3 | 30.0 |
| 1304.4 | 1.633 | 8.765 | 624.9 | 31.0 |
| 1353.7 | 1.667 | 8.619 | 629.1 | 32.7 |
| 1424.5 | 1.633 | 8.026 | 682.4 | 36.9 |
| 1527.7 | 1.817 | 8.324 | 623.9 | 38.2 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 1564.6 | 1.958 | 8.761 | 570.9 | 37.1 |
| 1629.3 | 2.150 | 9.237 | 516.8 | 36.7 |
| 1649.3 | 1.867 | 7.922 | 646.7 | 43.3 |
| 1672.4 | 1.867 | 7.813 | 655.8 | 44.5 |
| 1700.2 | 1.950 | 8.029 | 624.4 | 44.0 |
| 1703.2 | 1.883 | 7.740 | 659.0 | 45.8 |
| 1863.4 | 1.892 | 7.106 | 716.2 | 54.5 |
| 1885.0 | 2.050 | 7.613 | 642.2 | 51.5 |
| 2031.3 | 2.067 | 7.122 | 683.7 | 59.3 |
| 2189.9 | 2.850 | 9.110 | 455.1 | 50.0 |
| 2240.7 | 2.467 | 7.706 | 578.4 | 60.5 |
| 2334.6 | 2.425 | 7.271 | 618.2 | 66.8 |
| 2559.5 | 2.508 | 6.860 | 644.3 | 77.6 |
| 2667.3 | 2.808 | 7.370 | 566.8 | 75.3 |
| 2762.8 | 2.167 | 5.490 | 866.3 | 104.7 |
| 2902.9 | 2.275 | 5.486 | 846.0 | 110.1 |
| 2938.3 | 2.992 | 7.127 | 567.8 | 85.8 |
| 2958.3 | 2.703 | 6.397 | 665.6 | 96.2 |
| 3394.2 | 4.025 | 8.301 | 420.3 | 85.0 |
| 3554.3 | 3.725 | 7.336 | 494.4 | 100.8 |
| 4210.4 | 3.783 | 6.290 | 572.1 | 139.2 |
| 4304.3 | 4.508 | 7.332 | 449.7 | 122.1 |
| 7621.5 | 5.450 | 5.006 | 599.0 | 316.7 |
| 9229.2 | 4.942 | 3.748 | 840.1 | 512.2 |
| 10487.4 | 5.092 | 3.399 | 912.8 | 641.9 |
| 29215.3 | 12.208 | 2.925 | 684.9 | 2077.5 |
| 1453.8 | 1.500 | 7.223 | 791.3 | 41.9 |
| 1672.4 | 1.800 | 7.534 | 692.5 | 46.2 |
| 1746.4 | 1.990 | 7.977 | 622.1 | 45.5 |
| 2083.6 | 2.620 | 8.802 | 491.3 | 49.2 |
| 2092.9 | 1.940 | 6.489 | 774.5 | 67.1 |
| 2209.9 | 2.980 | 9.439 | 429.6 | 48.7 |
| 2331.6 | 2.480 | 7.446 | 597.0 | 65.1 |
| 2465.5 | 2.560 | 7.268 | 601.9 | 70.6 |
| 3013.8 | 3.340 | 7.758 | 493.7 | 80.8 |
| 3152.4 | 2.920 | 6.484 | 631.8 | 101.1 |
| 4133.4 | 4.180 | 7.079 | 483.7 | 121.4 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 4667.7 | 4.440 | 6.658 | 498.9 | 145.8 |
| 1275.1 | 1.800 | 9.881 | 528.0 | 26.8 |
| 1367.5 | 1.800 | 9.214 | 566.3 | 30.9 |
| 1443.0 | 1.360 | 6.597 | 909.8 | 45.5 |
| 1239.7 | 1.140 | 6.437 | 1018.5 | 40.1 |
| 1247.4 | 1.320 | 7.407 | 822.5 | 35.0 |
| 1275.1 | 1.660 | 9.113 | 596.2 | 29.1 |
| 1401.4 | 2.000 | 9.990 | 495.5 | 29.2 |
| 1974.3 | 2.180 | 7.729 | 613.4 | 53.1 |
| 2216.1 | 2.040 | 6.444 | 760.6 | 71.5 |
| 2628.8 | 2.840 | 7.562 | 549.3 | 72.3 |
| 1355.2 | 1.620 | 8.368 | 657.3 | 33.7 |
| 771.5 | 1.212 | 10.998 | 578.1 | 14.6 |
| 1332.1 | 2.135 | 11.217 | 427.1 | 24.7 |
| 1336.7 | 2.285 | 11.967 | 387.0 | 23.2 |
| 1307.5 | 2.147 | 11.496 | 415.5 | 23.7 |
| 810.0 | 1.529 | 13.209 | 428.6 | 12.8 |
| 867.0 | 1.428 | 11.532 | 507.9 | 15.6 |
| 885.5 | 1.551 | 12.264 | 458.2 | 15.0 |
| 893.2 | 1.515 | 11.873 | 479.0 | 15.6 |
| 997.9 | 1.563 | 10.964 | 510.7 | 18.9 |
| 1098.0 | 1.732 | 11.041 | 481.8 | 20.7 |
| 1171.9 | 1.586 | 9.471 | 586.9 | 25.7 |
| 1253.6 | 1.701 | 9.497 | 565.1 | 27.5 |
| 773.1 | 1.069 | 9.681 | 699.3 | 16.6 |
| 777.7 | 1.132 | 10.191 | 645.5 | 15.9 |
| 799.3 | 1.335 | 11.696 | 517.9 | 14.2 |
| 803.9 | .832 | 7.241 | 1060.2 | 23.1 |
| 808.5 | 1.027 | 8.896 | 776.3 | 18.9 |
| 814.7 | 1.386 | 11.910 | 499.2 | 14.2 |
| 816.2 | 1.066 | 9.144 | 741.4 | 18.6 |
| 825.4 | 1.119 | 9.489 | 697.4 | 18.1 |
| 828.5 | 1.043 | 8.814 | 777.6 | 19.6 |
| 830.1 | 1.263 | 10.655 | 584.5 | 16.2 |
| 833.1 | 1.277 | 10.727 | 577.6 | 16.2 |
| 834.7 | .958 | 8.038 | 889.6 | 21.5 |
| 834.7 | 1.364 | 11.441 | 523.8 | 15.2 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 857.8 | 1.169 | 9.541 | 678.5 | 18.7 |
| 862.4 | .923 | 7.495 | 971.9 | 23.9 |
| 882.4 | 1.343 | 10.654 | 567.0 | 17.2 |
| 888.6 | .996 | 7.846 | 894.0 | 23.6 |
| 899.4 | 1.168 | 9.088 | 712.8 | 20.6 |
| 924.0 | 1.082 | 8.198 | 820.8 | 23.4 |
| 925.5 | 1.193 | 9.025 | 710.0 | 21.3 |
| 934.8 | 1.045 | 7.825 | 875.2 | 24.8 |
| 945.6 | 1.004 | 7.435 | 939.5 | 26.5 |
| 951.7 | 1.152 | 8.474 | 769.6 | 23.4 |
| 956.3 | .950 | 6.951 | 1033.5 | 28.6 |
| 979.4 | 1.035 | 7.398 | 930.1 | 27.5 |
| 991.8 | 1.381 | 9.747 | 611.2 | 21.2 |
| 999.5 | 1.167 | 8.176 | 792.3 | 25.4 |
| 1122.7 | 1.145 | 7.140 | 916.2 | 32.7 |
| 1201.2 | 1.321 | 7.697 | 791.3 | 32.5 |
| 1242.8 | 1.417 | 7.980 | 736.9 | 32.4 |
| 1364.4 | 2.120 | 10.876 | 442.0 | 26.1 |
| 1381.4 | 1.960 | 9.932 | 503.4 | 28.9 |
| 1481.5 | 1.540 | 7.277 | 775.2 | 42.3 |
| 1532.3 | 2.210 | 10.096 | 466.4 | 31.6 |
| 1589.3 | 1.790 | 7.884 | 663.6 | 41.9 |
| 1607.8 | 1.420 | 6.183 | 950.1 | 54.1 |
| 1654.0 | 2.150 | 9.099 | 524.6 | 37.8 |
| 1680.1 | 1.300 | 5.416 | 1133.5 | 64.5 |
| 2075.9 | 2.020 | 6.811 | 723.1 | 63.4 |
| 2092.9 | 1.817 | 6.076 | 854.7 | 71.6 |
| 2136.0 | 1.920 | 6.292 | 802.9 | 70.6 |
| 2217.6 | 3.140 | 9.912 | 398.6 | 46.5 |
| 2545.6 | 2.370 | 6.517 | 697.7 | 81.2 |
| 2667.3 | 2.980 | 7.821 | 518.5 | 70.9 |
| 3899.8 | 1.992 | 4.808 | 1031.7 | 125.5 |
| 3007.6 | 2.670 | 6.214 | 689.4 | 100.7 |
| 3180.1 | 2.400 | 5.283 | 855.3 | 125.2 |
| 3289.4 | 2.517 | 5.356 | 823.9 | 127.8 |
| 3395.7 | 1.800 | 3.711 | 1406.1 | 190.3 |
| 3520.4 | 3.730 | 7.417 | 488.7 | 98.7 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 3799.2 | 3.158 | 5.819 | 676.9 | 135.8 |
| 3996.3 | 3.200 | 5.605 | 698.1 | 148.3 |
| 4124.1 | 3.217 | 5.460 | 714.9 | 157.1 |
| 4715.5 | 2.983 | 4.429 | 915.1 | 221.5 |
| 4895.7 | 3.217 | 4.599 | 848.6 | 221.4 |
| 5733.4 | 4.180 | 5.103 | 670.9 | 233.7 |
| 6083.0 | 4.242 | 4.881 | 696.3 | 259.2 |
| 774.6 | 1.265 | 11.428 | 544.7 | 14.1 |
| 1036.4 | 1.688 | 11.398 | 472.7 | 18.9 |
| 1104.2 | 1.584 | 10.040 | 554.0 | 22.9 |
| 1118.0 | 1.586 | 9.931 | 559.7 | 23.4 |
| 1199.7 | 1.585 | 9.248 | 601.2 | 27.0 |
| 774.6 | 1.818 | 10.677 | 603.2 | 15.1 |
| 793.1 | 1.085 | 9.577 | 701.7 | 17.2 |
| 810.0 | .958 | 8.279 | 863.8 | 20.4 |
| 814.7 | 1.032 | 8.869 | 776.9 | 19.1 |
| 817.7 | 1.029 | 8.807 | 783.6 | 19.3 |
| 831.6 | 1.344 | 11.315 | 533.6 | 15.3 |
| 847.0 | 1.197 | 9.894 | 646.6 | 17.8 |
| 865.5 | 1.212 | 9.806 | 648.3 | 18.4 |
| 1007.2 | 1.285 | 8.933 | 691.2 | 23.5 |
| 1102.6 | 1.333 | 8.464 | 716.2 | 27.1 |
| 1248.9 | 1.350 | 7.566 | 796.2 | 34.3 |
| 1290.5 | 1.658 | 8.995 | 604.3 | 29.8 |
| 1538.5 | 1.492 | 6.787 | 844.5 | 47.1 |
| 1703.2 | 1.783 | 7.329 | 715.2 | 48.3 |
| 1727.9 | 1.850 | 7.495 | 686.7 | 48.0 |
| 1869.6 | 1.733 | 6.490 | 819.2 | 59.9 |
| 2365.4 | 2.208 | 6.535 | 720.8 | 75.3 |
| 2671.9 | 2.533 | 6.637 | 662.6 | 83.7 |
| 3056.9 | 3.042 | 6.965 | 576.3 | 91.3 |
| 4610.8 | 4.208 | 6.389 | 534.1 | 150.1 |
| 6571.2 | 4.700 | 5.007 | 644.9 | 273.0 |
| 7410.5 | 5.458 | 5.156 | 581.1 | 298.9 |
| 9578.8 | 6.142 | 4.488 | 629.3 | 443.9 |
| 332.6 | .491 | 10.332 | 966.8 | 6.7 |
| 334.2 | .567 | 11.877 | 782.7 | 5.9 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 349.6 | .623 | 12.475 | 710.9 | 5.8 |
| 351.1 | .660 | 13.158 | 654.8 | 5.6 |
| 371.1 | .655 | 12.354 | 700.1 | 6.2 |
| 374.2 | .556 | 10.400 | 902.6 | 7.5 |
| 374.2 | .613 | 11.467 | 779.7 | 6.8 |
| 392.7 | .626 | 11.159 | 792.9 | 7.3 |
| 400.4 | .706 | 12.343 | 675.0 | 6.7 |
| 417.3 | .783 | 13.133 | 602.3 | 6.6 |
| 418.9 | .707 | 11.815 | 704.6 | 7.4 |
| 422.0 | .699 | 11.596 | 722.0 | 7.6 |
| 426.6 | .718 | 11.782 | 701.2 | 7.5 |
| 429.7 | .711 | 11.584 | 716.7 | 7.7 |
| 474.3 | .710 | 10.478 | 792.8 | 9.4 |
| 474.3 | .759 | 11.201 | 717.3 | 8.8 |
| 478.9 | .770 | 11.254 | 708.8 | 8.9 |
| 497.4 | .774 | 10.892 | 730.5 | 9.5 |
| 512.8 | .729 | 9.951 | 823.9 | 10.7 |
| 514.4 | .742 | 10.098 | 804.8 | 10.6 |
| 514.4 | .833 | 11.336 | 676.5 | 9.4 |
| 519.0 | .726 | 9.792 | 839.0 | 11.0 |
| 529.8 | 1.020 | 13.478 | 514.3 | 8.2 |
| 979.4 | .709 | 5.067 | 1640.6 | 40.2 |
| 576.0 | .754 | 9.164 | 879.7 | 13.1 |
| 579.0 | .938 | 11.339 | 637.4 | 10.6 |
| 606.8 | 1.090 | 12.575 | 533.2 | 10.0 |
| 614.5 | .940 | 10.709 | 674.2 | 11.9 |
| 642.2 | .803 | 8.753 | 892.4 | 15.3 |
| 659.1 | .974 | 10.344 | 685.7 | 13.3 |
| 660.7 | .894 | 9.472 | 781.6 | 14.5 |
| 662.2 | .968 | 10.233 | 695.3 | 13.5 |
| 686.8 | .904 | 9.213 | 799.1 | 15.5 |
| 697.6 | .878 | 8.810 | 848.0 | 16.5 |
| 723.8 | .995 | 9.623 | 729.3 | 15.6 |
| 731.5 | 1.100 | 10.526 | 634.1 | 14.5 |
| 739.2 | 1.020 | 9.659 | 717.6 | 15.9 |
| 740.7 | 1.160 | 10.962 | 592.9 | 14.1 |
| 742.3 | 1.140 | 10.751 | 609.8 | 14.4 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 1192.0 | 1.756 | 10.310 | 512.5 | 24.0 |
| 822.4 | 1.325 | 11.276 | 539.4 | 15.2 |
| 827.0 | 1.032 | 8.737 | 788.6 | 19.7 |
| 940.9 | 1.164 | 8.656 | 749.7 | 22.6 |
| 945.6 | 1.149 | 8.505 | 767.9 | 23.1 |
| 979.4 | 1.497 | 10.700 | 534.7 | 19.0 |
| 984.1 | 1.240 | 8.821 | 712.7 | 23.2 |
| 1059.5 | 1.177 | 7.773 | 830.2 | 28.4 |
| 1074.9 | 1.271 | 8.279 | 749.9 | 27.0 |
| 1155.0 | 1.432 | 8.680 | 673.9 | 27.7 |
| 1156.5 | 1.441 | 8.724 | 668.3 | 27.6 |
| 1178.1 | 1.360 | 8.084 | 742.4 | 30.3 |
| 1213.5 | 1.312 | 7.568 | 807.5 | 33.4 |
| 1247.4 | 1.505 | 8.448 | 675.3 | 30.7 |
| 1392.2 | 1.940 | 9.755 | 515.2 | 29.7 |
| 1399.9 | 1.060 | 5.301 | 1282.7 | 54.9 |
| 1510.7 | 1.810 | 8.387 | 620.4 | 37.5 |
| 1567.7 | 1.430 | 6.385 | 916.8 | 51.1 |
| 1908.1 | 1.208 | 4.433 | 1436.5 | 89.5 |
| 1958.9 | 2.320 | 8.290 | 554.3 | 49.1 |
| 2394.7 | 1.960 | 5.729 | 872.7 | 86.9 |
| 2918.3 | 3.180 | 7.628 | 514.6 | 79.6 |
| 3137.0 | 3.000 | 6.694 | 603.7 | 97.5 |
| 4119.5 | 3.080 | 5.234 | 762.1 | 163.7 |
| 4750.9 | 3.480 | 5.127 | 731.8 | 192.7 |
| 7971.0 | 2.190 | 1.923 | 2459.5 | 862.1 |
| 930.2 | 1.106 | 8.322 | 799.9 | 23.2 |
| 1042.6 | 1.260 | 8.459 | 737.3 | 25.6 |
| 2111.3 | 1.283 | 4.255 | 1452.3 | 103.2 |
| 2972.2 | 2.720 | 6.406 | 662.6 | 96.5 |
| 1435.3 | 1.850 | 9.023 | 570.4 | 33.1 |
| 1726.3 | 1.617 | 6.555 | 839.8 | 54.8 |
| 2254.6 | 1.742 | 5.408 | 980.9 | 86.7 |
| 2254.6 | 2.200 | 6.831 | 690.9 | 68.7 |
| 2314.6 | 2.092 | 6.326 | 765.1 | 76.1 |
| 3073.8 | 2.942 | 6.699 | 609.2 | 95.4 |
| 8599.4 | 3.817 | 3.107 | 1153.3 | 575.7 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 482.0 | .642 | 9.323 | 937.0 | 10.8 |
| 502.0 | .698 | 9.732 | 860.9 | 10.7 |
| 954.8 | 1.148 | 8.416 | 776.3 | 23.6 |
| 8741.0 | 4.567 | 3.657 | 895.7 | 497.2 |
| 925.5 | 1.118 | 8.452 | 783.4 | 22.8 |
| 1236.6 | 1.257 | 7.114 | 877.7 | 36.2 |
| 1577.0 | 1.808 | 8.027 | 648.5 | 40.9 |
| 1871.1 | 2.217 | 8.293 | 567.0 | 46.9 |
| 1954.3 | 2.217 | 7.940 | 592.2 | 51.2 |
| 2778.2 | 2.917 | 7.349 | 557.7 | 78.6 |
| 4903.4 | 2.992 | 4.271 | 947.6 | 238.8 |
| 6432.6 | 5.533 | 6.021 | 494.2 | 222.2 |
| 8165.1 | 5.500 | 4.715 | 633.0 | 360.2 |
| 2462.5 | 1.942 | 5.520 | 910.1 | 92.8 |
| 1079.5 | 1.472 | 9.545 | 604.4 | 23.5 |
| 1723.3 | 1.633 | 6.635 | 825.5 | 54.0 |
| 3140.1 | 2.767 | 6.168 | 682.3 | 105.9 |
| 2912.1 | 3.100 | 7.452 | 533.5 | 81.3 |
| 8248.2 | 7.083 | 6.011 | 437.5 | 285.4 |

Total number of fragments = 574

Average ballistic density for all fragments = 715.9

Average gamma for all fragments = 9.756

Number of hazardous fragments in zone = 86

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION

Location: White Sands Missile Range, NM

Date: 19 March 1980

Collection Zone: Azimuth: 90-95°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | No. Fragment |
|---|---|
| 0 - 308 | 2222 |
| 308 - 500 | 724 |
| 500 - 600 | 504 |
| 600 - 700 | 448 |
| 700 - 800 | 395 |
| 800 - 900 | 348 |
| 900 - 1000 | 310 |
| 1000 - 1200 | 274 |
| 1200 - 1400 | 242 |
| 1400 - 1700 | 208 |
| 1700 - 2000 | 171 |
| 2000 - 2500 | 145 |
| 2500 - 3000 | 116 |
| 3000+ | 94 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

Collection Zone: Azimuth: 90-95°
Range: 700 to 900 ft

| Fragment Wt. (gr) | No. Fragment |
|---|---|
| 0 - 308 | 461 |
| 308 - 770 | 131 |
| 770 - 1078 | 64 |
| 1078 - 1540 | 38 |
| 1540 - 2310 | 27 |
| 2310 - 3080 | 16 |
| 3080+ | 10 |

Collection Zone: Azimuth: 90-95°
Range: 900 to 1100 ft

| Fragment Wt. (gr) | No. Fragment |
|---|---|
| 0 - 308 | 305 |
| 308 - 770 | 137 |
| 770 - 1078 | 63 |
| 1078 - 1540 | 43 |
| 1540 - 2310 | 29 |
| 2310 - 3080 | 18 |
| 3080+ | 15 |

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

| Fragment Wt. (gr) | No. Fragment |
|---|---|
| 0 - 308 | 272 |
| 308 - 770 | 212 |
| 770 - 1078 | 109 |
| 1078 - 1540 | 87 |
| 1540 - 2310 | 68 |
| 2310 - 3080 | 47 |
| 3080+ | 34 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

Collection Zone: Azimuth: 90-95°
Range: 1500 to 1900 ft

| Fragment Wt. (gr) | No. Fragment |
|---|---|
| 0 - 308 | 73 |
| 308 - 770 | 69 |
| 770 - 1078 | 50 |
| 1078 - 1540 | 41 |
| 1540 - 2310 | 28 |
| 2310 - 3080 | 22 |
| 3080+ | 15 |

Collection Zone: Azimuth: 90-95°
Range: 1900 to 2300 ft

| Fragment Wt. (gr) | No. Fragment |
|---|---|
| 0 - 308 | 27 |
| 308 - 770 | 26 |
| 770 - 1078 | 25 |
| 1078 - 1540 | 23 |
| 1540 - 2310 | 22 |
| 2310 - 3080 | 18 |
| 3080+ | 17 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 311.08 | .72 | 16.2 | 511.[illegible] | 4.0 |
| 312.62 | .64 | 14.3 | 610.6 | 4.5 |
| 312.62 | .61 | 13.7 | 649.8 | 4.7 |
| 312.62 | .56 | 12.4 | 754.1 | 5.2 |
| 314.16 | .74 | 16.4 | 496.5 | 4.0 |
| 318.78 | .66 | 14.4 | 598.6 | 4.6 |
| 324.94 | .57 | 12.3 | 753.1 | 5.5 |
| 326.48 | .48 | 10.4 | 972.6 | 6.6 |
| 332.64 | .82 | 17.3 | 446.3 | 4.0 |
| 332.64 | .51 | 10.6 | 926.9 | 6.5 |
| 332.64 | .58 | 12.2 | 755.0 | 5.7 |
| 341.88 | .89 | 18.3 | 404.5 | 3.9 |
| 343.42 | .57 | 11.7 | 789.7 | 6.1 |
| 344.96 | .50 | 10.1 | 978.6 | 7.1 |
| 344.96 | .75 | 15.2 | 532.2 | 4.7 |
| 349.04 | .60 | 12.1 | 748.1 | 6.0 |
| 355.74 | .57 | 11.3 | 818.0 | 6.6 |
| 358.82 | .54 | 10.6 | 899.2 | 7.1 |
| 368.06 | .77 | 14.7 | 542.6 | 5.2 |
| 368.06 | .69 | 13.0 | 649.2 | 5.9 |
| 381.92 | .59 | 10.9 | 838.5 | 7.3 |
| 386.54 | .66 | 12.0 | 714.4 | 6.7 |
| 389.62 | .59 | 10.7 | 851.1 | 7.6 |
| 397.32 | 1.07 | 18.9 | 359.0 | 4.4 |
| 398.86 | .74 | 13.1 | 62.15 | 6.4 |
| 401.94 | .77 | 13.4 | 597.2 | 6.3 |
| 401.94 | .78 | 13.6 | 584.6 | 6.2 |
| 405.02 | .65 | 11.3 | 778.3 | 7.5 |
| 411.18 | .65 | 11.1 | 784.6 | 7.7 |
| 417.34 | .87 | 14.6 | 513.4 | 5.9 |
| 418.88 | .77 | 12.9 | 618.7 | 6.8 |
| 421.96 | .80 | 13.3 | 587.5 | 6.6 |
| 425.04 | .75 | 12.3 | 655.7 | 7.2 |
| 432.74 | .75 | 12.1 | 664.9 | 7.4 |
| 432.74 | .59 | 9.5 | 967.1 | 9.5 |
| 443.90 | .71 | 11.3 | 738.3 | 8.1 |
| 449.68 | .88 | 13.7 | 545.7 | 6.8 |
| 455.84 | .70 | 10.7 | 700.0 | 8.8 |
| 460.46 | .84 | 12.7 | 600.2 | 7.5 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 468.16 | 1.01 | 15.1 | 461.2 | 6.4 |
| 468.16 | .91 | 13.7 | 536.6 | 7.1 |
| 475.86 | .79 | 11.7 | 672.6 | 8.5 |
| 475.86 | 1.09 | 16.0 | 418.2 | 6.2 |
| 488.18 | 1.02 | 14.6 | 473.9 | 6.9 |
| 489.72 | .74 | 10.6 | 767.8 | 9.6 |
| 489.72 | .72 | 10.3 | 795.0 | 9.8 |
| 491.26 | .78 | 11.2 | 709.0 | 9.2 |
| 495.88 | 1.12 | 15.8 | 418.4 | 6.5 |
| 495.88 | .99 | 13.9 | 504.9 | 7.4 |
| 506.66 | .76 | 10.4 | 770.8 | 10.1 |
| 518.98 | .69 | 9.3 | 899.6 | 11.5 |
| 520.52 | .78 | 10.5 | 751.3 | 10.3 |
| 523.60 | 1.05 | 14.0 | 486.6 | 7.8 |
| 539.00 | .84 | 10.9 | 696.4 | 10.2 |
| 551.32 | .97 | 12.4 | 573.5 | 9.3 |
| 551.32 | .78 | 9.9 | 800.3 | 11.6 |
| 557.48 | .87 | 11.0 | 682.3 | 10.6 |
| 602.14 | .82 | 9.5 | 813.9 | 13.2 |
| 662.20 | 1.14 | 12.1 | 544.0 | 11.4 |
| 663.74 | .77 | 8.1 | 986.2 | 17.0 |
| 676.06 | 1.41 | 14.6 | 401.8 | 9.6 |
| 756.14 | .92 | 8.5 | 856.9 | 18.5 |
| 776.16 | .90 | 8.1 | 909.0 | 19.9 |
| 780.78 | 1.12 | 10.0 | 658.7 | 16.2 |
| 854.70 | 1.50 | 12.3 | 465.2 | 14.5 |
| 871.64 | 1.29 | 10.4 | 594.9 | 17.5 |
| 882.42 | 1.15 | 9.1 | 715.5 | 20.1 |
| 894.74 | 1.45 | 11.3 | 512.4 | 16.4 |
| 897.82 | 1.10 | 8.6 | 778.2 | 21.8 |
| 951.72 | 1.16 | 8.5 | 761.8 | 23.2 |
| 1044.12 | 1.46 | 9.8 | 591.9 | 22.2 |
| 1156.54 | 1.25 | 7.6 | 827.6 | 31.8 |
| 1235.08 | 1.71 | 9.7 | 552.3 | 26.5 |
| 1250.48 | 1.67 | 10.5 | 489.0 | 24.8 |
| 1252.02 | 1.64 | 9.2 | 596.1 | 28.4 |
| 1279.74 | 1.58 | 8.6 | 644.4 | 30.8 |
| 1395.24 | 1.63 | 8.2 | 670.5 | 35.5 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 1402.94 | 1.25 | 6.2 | 1003.9 | 46.8 |
| 1646.26 | 1.62 | 6.9 | 798.4 | 49.7 |
| 1660.12 | 1.46 | 6.2 | 941.0 | 56.1 |
| 1683.22 | 1.63 | 6.8 | 808.8 | 51.6 |
| 1743.28 | 2.34 | 9.4 | 487.0 | 38.6 |
| 1803.34 | 1.62 | 10.2 | 425.2 | 36.9 |
| 1894.20 | 1.66 | 6.1 | 885.7 | 64.2 |
| 1925.00 | 2.35 | 8.5 | 534.4 | 46.9 |
| 2077.46 | 1.91 | 6.4 | 787.0 | 67.1 |
| 2177.56 | 2.05 | 6.6 | 741.9 | 68.7 |
| 2915.22 | 1.88 | 4.5 | 1130.9 | 134.3 |
| 2990.68 | 1.99 | 4.7 | 1065.3 | 133.6 |
| 3374.14 | 3.55 | 7.4 | 504.5 | 95.3 |
| 5733.42 | 3.57 | 4.4 | 850.0 | 273.6 |
| 7056.28 | 4.28 | 4.2 | 796.9 | 345.7 |
| 13493.48 | 5.35 | 2.8 | 1090.4 | 1011.3 |
| 14891.80 | 6.07 | 2.9 | 995.8 | 1085.6 |
| 15800.40 | 9.09 | 4.0 | 576.5 | 816.1 |
| 2277.66 | 11.00 | 33.8 | 62.4 | 14.0 |
| 326.48 | .70 | 15.0 | 556.3 | 4.5 |
| 334.18 | .62 | 12.9 | 687.9 | 5.4 |
| 335.72 | .68 | 14.1 | 601.4 | 4.9 |
| 340.34 | .64 | 13.2 | 663.2 | 5.4 |
| 343.42 | .62 | 12.6 | 708.6 | 5.7 |
| 344.96 | .83 | 16.8 | 457.9 | 4.3 |
| 348.04 | .66 | 13.2 | 655.0 | 5.5 |
| 348.04 | .53 | 10.7 | 891.9 | 6.7 |
| 352.66 | .72 | 14.3 | 576.0 | 5.1 |
| 360.36 | .59 | 11.4 | 797.2 | 6.6 |
| 361.90 | .65 | 12.6 | 690.6 | 6.0 |
| 364.98 | .62 | 11.8 | 753.1 | 6.4 |
| 377.30 | .61 | 11.3 | 790.0 | 6.9 |
| 380.38 | .68 | 12.6 | 673.9 | 6.3 |
| 394.24 | .74 | 13.2 | 615.6 | 6.2 |
| 397.32 | .60 | 10.6 | 848.5 | 7.8 |
| 400.40 | .74 | 13.0 | 625.2 | 6.4 |
| 400.40 | 1.11 | 19.4 | 342.4 | 4.3 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 50-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 405.02 | .70 | 12.0 | 697.5 | 7.0 |
| 412.72 | .79 | 13.3 | 593.4 | 6.4 |
| 426.58 | .67 | 10.9 | 784.9 | 8.1 |
| 438.90 | .90 | 14.3 | 515.8 | 6.4 |
| 440.44 | .66 | 10.5 | 815.9 | 8.7 |
| 452.76 | .88 | 13.6 | 546.6 | 6.9 |
| 474.32 | 1.47 | 21.7 | 266.1 | 4.5 |
| 474.32 | .90 | 13.2 | 560.2 | 7.5 |
| 486.64 | .65 | 9.3 | 937.3 | 10.9 |
| 506.66 | .74 | 10.3 | 792.7 | 10.3 |
| 518.98 | 1.10 | 14.8 | 449.8 | 7.3 |
| 574.42 | 1.02 | 12.4 | 557.6 | 9.6 |
| 640.64 | 1.10 | 12.0 | 555.3 | 11.1 |
| 648.34 | 1.50 | 16.2 | 352.9 | 8.3 |
| 652.96 | 1.49 | 16.0 | 359.0 | 8.5 |
| 660.66 | 1.06 | 11.2 | 605.4 | 12.2 |
| 696.08 | .87 | 8.8 | 856.3 | 16.5 |
| 697.62 | 1.11 | 11.1 | 596.5 | 13.0 |
| 699.16 | 1.08 | 10.8 | 622.9 | 13.4 |
| 709.94 | 1.00 | 9.8 | 714.2 | 15.0 |
| 728.42 | 1.27 | 12.2 | 509.0 | 12.4 |
| 757.68 | 1.15 | 10.6 | 614.4 | 14.8 |
| 763.84 | .99 | 9.1 | 774.3 | 17.5 |
| 763.84 | 1.10 | 10.1 | 662.1 | 15.8 |
| 831.60 | 1.08 | 9.1 | 740.9 | 19.0 |
| 887.04 | 1.54 | 12.2 | 464.2 | 15.2 |
| 897.82 | 1.35 | 10.5 | 572.4 | 17.7 |
| 953.26 | 1.84 | 13.5 | 381.9 | 14.7 |
| 974.82 | 1.08 | 7.8 | 868.5 | 26.1 |
| 993.30 | 1.73 | 12.2 | 436.5 | 16.9 |
| 996.38 | 1.18 | 8.3 | 777.3 | 25.0 |
| 1007.16 | 1.44 | 10.0 | 582.8 | 20.9 |
| 1096.48 | 1.02 | 6.5 | 1064.4 | 35.0 |
| 1124.20 | 1.40 | 8.7 | 678.7 | 26.8 |
| 1124.20 | 1.31 | 8.2 | 678.7 | 26.8 |
| 1162.70 | 1.98 | 11.9 | 417.3 | 20.3 |
| 1211.98 | 1.36 | 7.9 | 764.2 | 32.1 |
| 1224.30 | 1.48 | 8.5 | 680.0 | 30.1 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 1352.12 | 1.79 | 9.3 | 564.6 | 30.3 |
| 1389.08 | 1.95 | 9.8 | 510.1 | 29.4 |
| 1479.94 | 1.71 | 8.1 | 661.8 | 38.1 |
| 1686.30 | 1.39 | 5.8 | 1029.0 | 60.8 |
| 2360.82 | 2.44 | 7.2 | 619.4 | 67.9 |
| 2753.52 | 2.04 | 5.2 | 945.0 | 110.4 |
| 3948.56 | 3.41 | 6.0 | 627.1 | 135.9 |
| 6221.60 | 3.18 | 3.6 | 1097.1 | 361.7 |
| 8109.64 | 4.81 | 4.2 | 768.7 | 406.3 |
| 12235.30 | 7.10 | 4.1 | 646.7 | 626.5 |
| 308.00 | .53 | 12.1 | 793.7 | 5.3 |
| 309.54 | .93 | 21.0 | 346.8 | 3.1 |
| 315.70 | .84 | 18.7 | 407.9 | 3.5 |
| 317.24 | .52 | 11.4 | 855.9 | 5.8 |
| 317.24 | .53 | 11.7 | 822.2 | 5.6 |
| 318.78 | .57 | 12.4 | 750.6 | 5.3 |
| 318.78 | .63 | 13.8 | 637.5 | 4.8 |
| 320.32 | .74 | 16.1 | 505.2 | 4.1 |
| 328.02 | .74 | 15.7 | 517.4 | 4.3 |
| 337.26 | .50 | 10.3 | 968.4 | 6.8 |
| 346.50 | .84 | 16.9 | 450.9 | 4.3 |
| 348.04 | .61 | 12.2 | 734.1 | 5.9 |
| 351.12 | .75 | 15.0 | 538.4 | 4.9 |
| 360.36 | .59 | 11.5 | 787.1 | 6.5 |
| 368.06 | .75 | 14.2 | 571.2 | 5.4 |
| 369.60 | .53 | 10.1 | 947.2 | 7.6 |
| 375.76 | .56 | 10.4 | 903.9 | 7.5 |
| 375.76 | .73 | 13.7 | 597.5 | 5.7 |
| 377.30 | .93 | 17.2 | 423.4 | 4.6 |
| 378.84 | .70 | 13.0 | 641.4 | 6.1 |
| 388.08 | 1.08 | 19.5 | 345.8 | 4.1 |
| 401.94 | .80 | 14.0 | 559.6 | 6.0 |
| 405.02 | .60 | 10.3 | 880.3 | 8.2 |
| 408.10 | .60 | 10.2 | 889.2 | 8.3 |
| 411.18 | .66 | 11.3 | 765.1 | 7.6 |
| 411.18 | .69 | 11.7 | 719.0 | 7.3 |
| 415.80 | .60 | 10.1 | 894.7 | 8.6 |
| 418.88 | .60 | 10.0 | 910.4 | 8.7 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 421.96 | .86 | 14.2 | 533.7 | 6.2 |
| 423.50 | .69 | 11.3 | 747.0 | 7.8 |
| 432.74 | .93 | 15.0 | 484.9 | 6.0 |
| 435.82 | .83 | 13.4 | 573.2 | 6.8 |
| 440.44 | .78 | 12.3 | 644.3 | 7.4 |
| 458.92 | .75 | 11.4 | 713.7 | 8.4 |
| 468.16 | .81 | 12.1 | 644.6 | 8.1 |
| 469.70 | .77 | 11.5 | 691.1 | 8.5 |
| 498.96 | .66 | 9.3 | 928.5 | 11.2 |
| 498.96 | .79 | 11.1 | 709.3 | 9.4 |
| 526.68 | 1.04 | 13.8 | 496.6 | 7.9 |
| 551.32 | .82 | 10.4 | 747.9 | 11.1 |
| 555.94 | .74 | 9.3 | 876.9 | 12.4 |
| 563.64 | .70 | 8.6 | 970.7 | 13.6 |
| 585.20 | .75 | 8.9 | 910.1 | 13.7 |
| 617.54 | .90 | 10.2 | 726.9 | 12.6 |
| 620.62 | 1.13 | 12.7 | 516.7 | 10.1 |
| 645.26 | .94 | 10.2 | 704.6 | 13.1 |
| 654.50 | .93 | 10.0 | 726.3 | 13.6 |
| 719.18 | 1.29 | 12.6 | 490.9 | 11.9 |
| 731.50 | 1.10 | 10.5 | 634.1 | 14.5 |
| 771.54 | 1.60 | 14.5 | 381.2 | 11.1 |
| 799.26 | 1.50 | 13.1 | 435.1 | 12.7 |
| 803.88 | 1.29 | 11.2 | 548.7 | 14.9 |
| 874.72 | 1.63 | 13.0 | 420.3 | 13.9 |
| 944.02 | 1.28 | 9.5 | 651.9 | 20.7 |
| 980.98 | 1.09 | 7.8 | 862.0 | 26.2 |
| 1021.02 | 1.93 | 13.2 | 380.8 | 16.1 |
| 1033.34 | 1.70 | 11.5 | 466.2 | 18.7 |
| 1116.50 | 1.28 | 8.0 | 771.0 | 28.9 |
| 1182.72 | 1.99 | 11.8 | 421.3 | 20.9 |
| 1199.66 | 1.71 | 10.0 | 536.5 | 25.0 |
| 1210.44 | 1.38 | 8.0 | 746.7 | 31.5 |
| 1230.46 | 1.65 | 9.4 | 580.6 | 27.3 |
| 1253.56 | 1.39 | 7.8 | 764.9 | 33.6 |
| 1272.04 | 1.81 | 10.0 | 522.4 | 26.6 |
| 1299.76 | 2.34 | 12.6 | 363.1 | 21.5 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 1302.84 | 1.57 | 8.4 | 662.3 | 32.1 |
| 1401.40 | 1.43 | 7.1 | 819.5 | 40.8 |
| 1572.34 | 2.11 | 9.4 | 513.0 | 34.8 |
| 1652.42 | 1.90 | 8.0 | 630.9 | 42.7 |
| 1675.52 | 1.75 | 7.3 | 723.8 | 47.7 |
| 1730.96 | 1.63 | 6.6 | 831.8 | 54.6 |
| 2068.22 | 1.67 | 5.7 | 958.3 | 76.1 |
| 2702.70 | 2.38 | 6.2 | 736.1 | 91.2 |
| 3529.68 | 3.12 | 6.2 | 640.5 | 118.7 |
| 3873.10 | 2.18 | 3.9 | 1203.3 | 204.5 |
| 15731.10 | 8.23 | 3.7 | 666.3 | 893.5 |
| 311.08 | .40 | 9.0 | 1229.7 | 7.2 |
| 314.16 | .48 | 10.7 | 944.7 | 6.1 |
| 315.70 | .49 | 10.9 | 920.4 | 6.0 |
| 315.70 | .35 | 7.8 | 1524.7 | 8.5 |
| 317.24 | .48 | 10.6 | 954.0 | 6.2 |
| 317.24 | .38 | 8.4 | 1354.3 | 7.9 |
| 317.24 | .42 | 9.3 | 1165.5 | 7.1 |
| 317.24 | .54 | 11.9 | 799.5 | 5.5 |
| 318.78 | .59 | 13.0 | 703.4 | 5.1 |
| 321.86 | .48 | 10.4 | 967.8 | 6.4 |
| 321.86 | .63 | 13.7 | 643.7 | 4.9 |
| 323.40 | .36 | 7.8 | 1497.2 | 8.6 |
| 323.40 | .38 | 8.2 | 1380.6 | 8.2 |
| 326.48 | .49 | 10.5 | 951.8 | 6.5 |
| 326.48 | .44 | 9.4 | 1118.6 | 7.2 |
| 328.02 | .38 | 8.1 | 1400.3 | 8.4 |
| 328.02 | .44 | 9.4 | 1123.9 | 7.3 |
| 328.02 | .71 | 15.2 | 548.3 | 4.5 |
| 329.56 | .60 | 12.7 | 709.1 | 5.4 |
| 331.10 | .37 | 7.8 | 1471.1 | 8.8 |
| 334.18 | .54 | 11.3 | 842.2 | 6.1 |
| 334.18 | .42 | 8.8 | 1227.7 | 7.9 |
| 334.18 | .55 | 11.5 | 819.3 | 6.0 |
| 335.72 | .57 | 11.9 | 780.1 | 5.9 |
| 335.72 | .66 | 13.8 | 626.1 | 5.1 |
| 337.26 | .53 | 11.0 | 874.1 | 6.4 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 338.80 | .42 | 8.7 | 1244.7 | 8.1 |
| 341.88 | .50 | 10.2 | 967.0 | 6.9 |
| 341.88 | .49 | 10.0 | 996.7 | 7.1 |
| 344.96 | .50 | 10.1 | 975.7 | 7.1 |
| 346.50 | .69 | 13.9 | 604.5 | 5.2 |
| 349.58 | .47 | 9.4 | 1084.9 | 7.7 |
| 351.12 | .64 | 12.8 | 685.8 | 5.7 |
| 352.66 | .46 | 9.1 | 1130.4 | 8.0 |
| 354.20 | .81 | 16.0 | 485.9 | 4.6 |
| 354.20 | .40 | 7.9 | 1400.1 | 9.3 |
| 357.28 | .48 | 9.4 | 1074.4 | 7.9 |
| 358.82 | .38 | 7.4 | 1531.8 | 10.1 |
| 361.90 | .45 | 8.7 | 1198.9 | 8.6 |
| 372.68 | .50 | 9.4 | 1054.1 | 8.3 |
| 372.68 | .44 | 8.3 | 1276.9 | 9.4 |
| 372.68 | .66 | 12.4 | 695.1 | 6.3 |
| 378.84 | .63 | 11.6 | 757.6 | 6.8 |
| 385.00 | .48 | 8.7 | 1157.7 | 9.2 |
| 386.54 | .47 | 8.5 | 1199.6 | 9.4 |
| 386.54 | .79 | 14.3 | 550.5 | 5.6 |
| 388.08 | .71 | 12.8 | 648.7 | 6.3 |
| 389.62 | .52 | 9.3 | 1039.0 | 8.7 |
| 391.16 | .62 | 11.1 | 801.2 | 7.3 |
| 395.78 | .67 | 11.9 | 721.7 | 6.9 |
| 395.78 | .57 | 10.1 | 919.7 | 8.2 |
| 395.78 | .46 | 8.1 | 1268.6 | 10.1 |
| 398.86 | .42 | 7.4 | 1465.4 | 11.3 |
| 400.40 | .58 | 10.1 | 906.5 | 8.2 |
| 401.94 | .69 | 12.0 | 701.3 | 7.0 |
| 408.10 | .70 | 12.0 | 696.8 | 7.1 |
| 409.64 | .43 | 7.3 | 1452.8 | 11.6 |
| 412.72 | .91 | 15.4 | 475.4 | 5.6 |
| 412.72 | .55 | 9.3 | 1011.8 | 9.2 |
| 414.26 | .83 | 14.0 | 547.8 | 6.1 |
| 420.42 | .45 | 7.5 | 1392.7 | 11.7 |
| 421.96 | .65 | 10.8 | 805.2 | 8.1 |
| 423.50 | .59 | 9.8 | 934.5 | 9.0 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 425.04 | .46 | 7.6 | 1362.4 | 11.7 |
| 426.58 | .48 | 7.9 | 1282.7 | 11.3 |
| 429.66 | .43 | 7.0 | 1523.8 | 12.8 |
| 432.74 | .62 | 10.0 | 886.4 | 9.0 |
| 432.74 | .78 | 12.6 | 628.2 | 7.1 |
| 440.44 | .48 | 7.6 | 1324.4 | 12.0 |
| 448.14 | .53 | 8.3 | 1161.4 | 11.3 |
| 457.38 | .51 | 7.8 | 1255.8 | 12.2 |
| 462.00 | .55 | 8.3 | 1132.7 | 11.5 |
| 465.08 | .63 | 9.5 | 930.1 | 10.2 |
| 465.08 | .74 | 11.1 | 730.6 | 8.7 |
| 466.62 | .54 | 8.1 | 1175.9 | 12.0 |
| 469.70 | .60 | 8.9 | 1010.6 | 10.9 |
| 477.40 | .89 | 13.0 | 568.6 | 7.6 |
| 480.48 | .57 | 8.3 | 1116.5 | 12.0 |
| 492.80 | .87 | 12.4 | 607.3 | 8.3 |
| 494.34 | .77 | 10.9 | 731.6 | 9.4 |
| 498.86 | .91 | 12.8 | 574.8 | 8.1 |
| 503.58 | .83 | 11.5 | 666.0 | 9.1 |
| 511.28 | .93 | 12.7 | 570.1 | 8.4 |
| 532.84 | .82 | 10.8 | 717.6 | 10.3 |
| 534.38 | 1.01 | 13.2 | 526.5 | 8.4 |
| 535.92 | .87 | 11.4 | 660.4 | 9.8 |
| 535.92 | .63 | 8.2 | 1071.7 | 13.5 |
| 537.46 | .87 | 8.7 | 980.0 | 12.8 |
| 537.46 | .77 | 10.0 | 795.4 | 11.1 |
| 563.64 | .75 | 9.3 | 867.8 | 12.6 |
| 571.34 | .85 | 10.4 | 729.1 | 11.4 |
| 571.34 | .95 | 11.6 | 617.0 | 10.2 |
| 589.82 | .65 | 7.7 | 1125.5 | 15.9 |
| 595.98 | .80 | 9.4 | 832.9 | 13.2 |
| 600.60 | .98 | 11.4 | 619.1 | 10.9 |
| 603.68 | .73 | 8.5 | 967.9 | 14.8 |
| 603.68 | .82 | 9.5 | 813.0 | 13.2 |
| 605.22 | .92 | 10.6 | 685.9 | 11.8 |
| 611.38 | 1.00 | 11.4 | 611.4 | 11.1 |
| 611.38 | 1.13 | 12.9 | 509.0 | 9.8 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 614.46 | .85 | 9.7 | 784.1 | 13.2 |
| 637.56 | 1.00 | 11.0 | 637.6 | 12.1 |
| 639.10 | .80 | 8.8 | 893.2 | 15.2 |
| 665.28 | .63 | 6.6 | 1330.4 | 20.9 |
| 668.36 | .97 | 10.2 | 699.6 | 13.7 |
| 682.22 | .95 | 9.7 | 736.8 | 14.6 |
| 682.22 | .77 | 7.9 | 1009.7 | 18.0 |
| 686.84 | 1.05 | 10.7 | 638.4 | 13.4 |
| 688.38 | 1.15 | 11.7 | 558.2 | 12.2 |
| 689.92 | .80 | 8.1 | 964.2 | 17.7 |
| 696.08 | 1.07 | 10.8 | 628.9 | 13.5 |
| 709.94 | .85 | 8.4 | 905.9 | 17.6 |
| 743.82 | 1.27 | 12.0 | 519.7 | 12.9 |
| 748.44 | .82 | 7.7 | 1007.9 | 20.3 |
| 751.52 | .75 | 7.0 | 1157.0 | 22.4 |
| 757.68 | .90 | 8.3 | 887.4 | 19.0 |
| 759.22 | 1.08 | 10.0 | 676.4 | 15.9 |
| 793.10 | 1.17 | 10.3 | 626.7 | 16.0 |
| 810.04 | .75 | 6.5 | 1247.1 | 26.0 |
| 813.12 | .88 | 7.6 | 985.0 | 22.3 |
| 845.46 | .90 | 7.5 | 990.2 | 23.6 |
| 910.14 | 1.28 | 9.8 | 628.5 | 19.2 |
| 967.12 | 1.68 | 12.2 | 444.1 | 16.5 |
| 1010.24 | .99 | 6.9 | 1025.6 | 30.6 |
| 1013.32 | 1.73 | 12.0 | 445.3 | 17.6 |
| 1057.98 | 1.08 | 7.1 | 942.6 | 30.8 |
| 1067.22 | .92 | 6.0 | 1209.4 | 36.8 |
| 1087.24 | 1.16 | 7.5 | 870.2 | 30.3 |
| 1161.16 | 1.09 | 6.6 | 1020.4 | 36.8 |
| 1173.48 | .96 | 5.7 | 1247.6 | 42.6 |
| 1187.34 | 1.68 | 9.9 | 545.3 | 24.9 |
| 1213.52 | .94 | 5.4 | 1331.5 | 46.6 |
| 1221.22 | 1.30 | 7.5 | 823.9 | 34.1 |
| 1242.78 | .99 | 5.6 | 1261.7 | 46.4 |
| 1248.94 | 1.58 | 8.9 | 628.9 | 29.3 |
| 1250.48 | 1.35 | 7.6 | 797.2 | 34.4 |
| 1270.50 | 1.43 | 7.9 | 743.0 | 33.5 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 1278.20 | 1.30 | 7.1 | 862.4 | 37.3 |
| 1312.08 | 1.23 | 6.6 | 961.8 | 41.6 |
| 1350.58 | 1.55 | 8.0 | 699.9 | 35.0 |
| 1365.98 | 1.83 | 9.4 | 551.8 | 30.3 |
| 1540.00 | 1.68 | 7.6 | 707.2 | 41.9 |
| 1669.36 | 1.73 | 7.3 | 733.6 | 47.9 |
| 1683.22 | 1.85 | 7.7 | 668.9 | 45.5 |
| 1721.72 | 1.59 | 6.5 | 858.8 | 55.4 |
| 1757.14 | 1.87 | 7.4 | 687.1 | 49.1 |
| 1760.22 | 2.77 | 11.0 | 381.8 | 33.2 |
| 1834.14 | 1.88 | 7.2 | 711.5 | 53.2 |
| 1901.90 | 2.03 | 7.5 | 657.6 | 52.9 |
| 1903.44 | 2.88 | 10.6 | 389.4 | 37.4 |
| 2051.28 | 2.07 | 7.1 | 688.8 | 60.4 |
| 2339.26 | 2.00 | 6.0 | 827.1 | 81.3 |
| 2491.72 | 3.02 | 8.5 | 474.8 | 61.1 |
| 2713.48 | 2.68 | 6.9 | 618.5 | 81.6 |
| 2832.06 | 3.52 | 8.7 | 428.8 | 67.7 |
| 2841.30 | 3.78 | 9.3 | 386.6 | 63.5 |
| 3010.70 | 2.29 | 5.3 | 868.8 | 117.6 |
| 3426.50 | 2.32 | 4.7 | 969.7 | 150.4 |
| 4341.26 | 3.71 | 6.0 | 607.5 | 150.9 |
| 4931.08 | 4.08 | 5.8 | 598.3 | 177.1 |
| 5228.30 | 4.06 | 5.4 | 639.1 | 200.1 |
| 5283.74 | 4.01 | 5.3 | 658.0 | 206.9 |
| 8739.50 | 5.22 | 4.2 | 732.8 | 434.8 |
| 11676.28 | 5.58 | 3.3 | 885.8 | 726.0 |
| 12304.60 | 7.41 | 4.2 | 610.0 | 607.1 |
| 14402.08 | 6.83 | 3.3 | 806.9 | 902.4 |
| 309.54 | .65 | 14.6 | 593.7 | 4.4 |
| 314.16 | .63 | 14.1 | 627.3 | 4.7 |
| 314.16 | .61 | 13.7 | 652.8 | 4.8 |
| 318.78 | .49 | 10.9 | 917.3 | 6.1 |
| 323.40 | .56 | 12.2 | 762.4 | 5.5 |
| 323.40 | .53 | 11.6 | 826.8 | 5.8 |
| 326.48 | .61 | 13.1 | 680.6 | 5.2 |
| 326.48 | .53 | 11.5 | 835.1 | 5.9 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 337.26 | .50 | 10.3 | 960.9 | 6.8 |
| 338.80 | .56 | 11.5 | 813.2 | 6.1 |
| 341.88 | .73 | 14.9 | 551.9 | 4.8 |
| 343.42 | .56 | 11.4 | 825.4 | 6.3 |
| 346.50 | .53 | 10.7 | 897.5 | 6.7 |
| 354.20 | .58 | 11.4 | 807.4 | 6.5 |
| 360.36 | .60 | 11.6 | 779.8 | 6.5 |
| 361.90 | .61 | 11.8 | 762.6 | 6.4 |
| 361.90 | .62 | 12.0 | 744.9 | 6.3 |
| 366.52 | .57 | 10.9 | 851.6 | 7.0 |
| 369.60 | .56 | 10.6 | 886.0 | 7.3 |
| 371.14 | .68 | 12.8 | 666.0 | 6.0 |
| 374.22 | .67 | 12.5 | 686.2 | 6.2 |
| 375.76 | .68 | 12.7 | 664.7 | 6.1 |
| 375.76 | .65 | 12.2 | 708.9 | 6.4 |
| 378.84 | .72 | 13.3 | 623.2 | 5.9 |
| 381.92 | .66 | 12.1 | 715.9 | 6.6 |
| 386.54 | .61 | 11.0 | 818.3 | 7.3 |
| 392.70 | .69 | 12.2 | 690.6 | 6.7 |
| 409.64 | .60 | 10.3 | 876.0 | 8.3 |
| 415.80 | .61 | 10.2 | 877.5 | 8.5 |
| 420.42 | .59 | 9.9 | 922.3 | 8.9 |
| 441.98 | .57 | 9.0 | 1024.6 | 10.2 |
| 451.22 | .63 | 9.8 | 893.5 | 9.5 |
| 452.76 | .66 | 10.2 | 844.7 | 9.2 |
| 466.62 | .68 | 10.2 | 828.5 | 9.5 |
| 475.86 | .65 | 9.5 | 918.2 | 10.4 |
| 483.56 | .63 | 9.1 | 976.8 | 11.1 |
| 485.10 | .74 | 10.7 | 764.8 | 9.5 |
| 486.64 | .63 | 9.1 | 964.5 | 11.1 |
| 494.34 | .76 | 10.7 | 748.8 | 9.6 |
| 514.36 | .74 | 10.0 | 813.7 | 10.7 |
| 537.46 | .74 | 9.7 | 840.4 | 11.6 |
| 548.24 | .77 | 9.9 | 807.8 | 11.6 |
| 565.18 | .81 | 10.0 | 777.2 | 11.7 |
| 572.88 | .78 | 9.6 | 827.8 | 12.5 |
| 574.42 | .79 | 9.7 | 814.6 | 12.4 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 586.74 | .78 | 9.3 | 846.1 | 13.1 |
| 602.14 | .78 | 9.1 | 876.5 | 13.8 |
| 603.68 | .79 | 9.2 | 861.0 | 13.7 |
| 612.92 | .81 | 9.3 | 839.1 | 13.8 |
| 637.56 | .74 | 8.2 | 995.5 | 16.3 |
| 643.72 | .81 | 8.8 | 879.7 | 15.2 |
| 663.74 | .89 | 9.4 | 785.2 | 14.6 |
| 700.70 | .90 | 9.0 | 825.5 | 16.3 |
| 726.88 | .84 | 8.1 | 938.4 | 18.6 |
| 776.16 | .86 | 7.7 | 976.0 | 20.9 |
| 796.18 | .90 | 7.9 | 930.1 | 20.9 |
| 894.74 | 1.03 | 8.0 | 858.8 | 23.1 |
| 329.56 | .70 | 14.9 | 563.1 | 4.6 |
| 334.18 | .59 | 12.4 | 729.6 | 5.6 |
| 334.18 | .78 | 16.4 | 484.5 | 4.3 |
| 337.26 | .69 | 14.3 | 587.4 | 4.9 |
| 340.34 | .62 | 12.7 | 699.1 | 5.6 |
| 341.88 | .59 | 12.1 | 752.4 | 5.9 |
| 343.42 | .66 | 13.5 | 639.7 | 5.3 |
| 354.20 | .69 | 13.7 | 612.8 | 5.4 |
| 355.74 | .71 | 14.0 | 592.2 | 5.3 |
| 358.82 | .66 | 12.9 | 668.0 | 5.8 |
| 363.44 | .63 | 12.2 | 718.7 | 6.2 |
| 364.98 | .71 | 13.6 | 610.0 | 5.6 |
| 369.60 | .78 | 14.7 | 541.6 | 5.2 |
| 371.14 | .72 | 13.6 | 605.1 | 5.7 |
| 372.68 | .66 | 12.4 | 694.6 | 6.3 |
| 372.68 | .74 | 13.9 | 587.4 | 5.6 |
| 375.76 | .80 | 14.8 | 528.4 | 5.3 |
| 378.84 | .67 | 12.4 | 691.5 | 6.4 |
| 385.00 | .73 | 13.3 | 613.1 | 6.0 |
| 394.24 | .67 | 11.9 | 719.4 | 6.9 |
| 426.58 | .80 | 13.2 | 591.1 | 6.7 |
| 408.10 | .80 | 13.8 | 566.5 | 6.2 |
| 411.18 | .74 | 12.6 | 643.2 | 6.8 |
| 417.34 | .73 | 12.2 | 670.0 | 7.1 |
| 428.12 | .79 | 12.9 | 612.7 | 6.9 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 429.66 | .81 | 13.2 | 590.7 | 6.8 |
| 432.74 | .83 | 13.4 | 572.9 | 6.7 |
| 434.28 | .82 | 13.2 | 584.3 | 6.8 |
| 451.22 | .89 | 13.8 | 539.9 | 6.8 |
| 452.76 | .84 | 13.1 | 583.1 | 7.2 |
| 457.38 | .77 | 11.8 | 678.6 | 8.1 |
| 460.46 | .85 | 12.9 | 589.3 | 7.4 |
| 462.00 | .85 | 12.9 | 585.2 | 7.4 |
| 462.00 | .80 | 12.1 | 648.4 | 8.0 |
| 463.54 | .79 | 11.9 | 666.4 | 8.1 |
| 468.16 | .82 | 12.3 | 630.4 | 7.9 |
| 480.48 | .78 | 11.4 | 697.9 | 8.8 |
| 506.66 | .95 | 13.1 | 550.2 | 8.1 |
| 515.90 | .80 | 10.8 | 724.3 | 9.9 |
| 515.90 | .99 | 13.4 | 523.7 | 8.0 |
| 526.68 | .90 | 11.9 | 620.2 | 9.2 |
| 534.38 | .83 | 10.9 | 701.9 | 10.2 |
| 543.62 | .92 | 11.9 | 612.1 | 9.5 |
| 545.16 | .96 | 12.3 | 582.2 | 9.2 |
| 560.56 | 1.00 | 12.5 | 562.4 | 9.4 |
| 572.88 | .85 | 10.4 | 733.1 | 11.5 |
| 574.42 | .87 | 10.6 | 703.6 | 11.2 |
| 612.92 | 1.02 | 11.7 | 594.5 | 10.9 |
| 617.54 | .92 | 10.4 | 701.2 | 12.3 |
| 617.54 | .95 | 10.7 | 669.9 | 12.0 |
| 626.78 | .94 | 10.4 | 693.2 | 12.5 |
| 632.94 | 1.00 | 11.1 | 631.7 | 11.9 |
| 640.64 | .95 | 10.4 | 687.6 | 12.8 |
| 663.74 | 1.08 | 11.4 | 590.5 | 12.1 |
| 672.98 | 1.09 | 11.3 | 591.0 | 12.3 |
| 677.60 | 1.15 | 11.9 | 547.2 | 11.8 |
| 682.22 | 1.09 | 11.2 | 599.5 | 12.7 |
| 693.00 | .91 | 9.2 | 803.2 | 15.7 |
| 722.26 | 1.06 | 10.2 | 664.6 | 14.7 |
| 780.78 | 1.01 | 9.0 | 773.6 | 18.0 |
| 797.72 | 1.10 | 9.6 | 695.7 | 17.3 |
| 803.88 | .92 | 8.0 | 909.4 | 20.8 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 848.54 | 1.05 | 8.7 | 786.9 | 20.3 |
| 857.78 | .98 | 8.0 | 890.9 | 22.4 |
| 907.06 | 1.07 | 8.3 | 818.1 | 22.8 |
| 924.00 | 1.12 | 8.5 | 781.2 | 22.7 |
| 942.48 | 1.03 | 7.7 | 898.5 | 25.6 |
| 979.44 | 1.17 | 8.3 | 777.2 | 24.4 |
| 990.22 | 1.16 | 8.2 | 795.1 | 25.2 |
| 397.32 | .85 | 15.0 | 503.5 | 5.5 |
| 443.52 | .90 | 14.2 | 518.0 | 6.5 |
| 460.46 | .89 | 13.5 | 548.3 | 7.1 |
| 463.54 | .94 | 14.2 | 509.3 | 6.8 |
| 503.58 | .95 | 13.2 | 545.8 | 8.0 |
| 506.66 | .89 | 12.3 | 603.8 | 8.6 |
| 526.68 | .98 | 13.1 | 541.0 | 8.4 |
| 562.10 | 1.05 | 13.0 | 526.1 | 9.0 |
| 572.88 | 1.01 | 12.4 | 563.2 | 9.6 |
| 589.82 | 1.04 | 12.3 | 556.4 | 9.9 |
| 603.68 | 1.10 | 12.8 | 520.0 | 9.8 |
| 605.22 | 1.11 | 12.8 | 516.9 | 9.8 |
| 628.32 | 1.07 | 11.9 | 570.1 | 11.0 |
| 642.18 | 1.17 | 12.7 | 508.3 | 10.5 |
| 643.72 | 1.15 | 12.5 | 520.1 | 10.7 |
| 660.66 | 1.19 | 13.6 | 512.0 | 10.9 |
| 683.76 | 1.04 | 10.7 | 642.4 | 13.3 |
| 694.54 | 1.30 | 13.1 | 470.8 | 11.1 |
| 773.08 | 1.21 | 11.0 | 577.7 | 14.5 |
| 862.40 | 1.28 | 10.4 | 597.9 | 17.3 |
| 865.48 | 1.27 | 10.3 | 606.3 | 17.6 |
| 928.62 | 1.30 | 9.8 | 627.2 | 19.7 |
| 956.34 | 1.36 | 9.9 | 603.7 | 20.0 |
| 976.36 | 1.35 | 9.7 | 623.4 | 21.0 |
| 987.14 | 1.38 | 9.8 | 606.0 | 20.9 |
| 1022.56 | 1.18 | 8.1 | 799.7 | 26.4 |
| 1131.90 | 1.04 | 6.4 | 1064.7 | 36.5 |
| 2653.42 | 1.41 | 3.7 | 1589.6 | 148.7 |
| 1155.00 | 1.73 | 10.5 | 506.1 | 22.9 |
| 1199.66 | 1.44 | 8.4 | 693.0 | 29.7 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 1256.64 | 1.37 | 7.6 | 786.5 | 34.3 |
| 1261.26 | 1.41 | 7.8 | 754.7 | 33.6 |
| 1276.64 | 1.83 | 10.0 | 517.8 | 26.5 |
| 1292.06 | 1.28 | 7.0 | 888.7 | 38.7 |
| 1309.80 | 1.17 | 6.3 | 1034.3 | 43.5 |
| 1389.08 | 1.49 | 7.5 | 762.5 | 38.4 |
| 1413.72 | 1.37 | 6.8 | 884.8 | 43.5 |
| 1455.30 | 1.55 | 7.5 | 754.1 | 40.6 |
| 1476.86 | 1.38 | 6.6 | 907.7 | 46.9 |
| 1578.50 | 1.27 | 5.6 | 1107.3 | 58.5 |
| 1692.46 | 1.65 | 6.8 | 798.5 | 51.6 |
| 1697.08 | 1.75 | 7.2 | 733.1 | 48.9 |
| 1741.74 | 1.34 | 5.4 | 1122.9 | 67.3 |
| 1791.02 | 1.45 | 5.7 | 1025.8 | 65.7 |
| 1814.12 | 1.38 | 5.3 | 1115.0 | 70.7 |
| 1824.90 | 2.04 | 7.8 | 626.3 | 48.5 |
| 1832.60 | 1.65 | 6.3 | 864.7 | 60.5 |
| 1858.78 | 1.82 | 6.8 | 759.1 | 56.5 |
| 1995.84 | 2.07 | 7.2 | 671.8 | 57.3 |
| 1998.92 | 3.40 | 11.9 | 318.8 | 34.9 |
| 2176.02 | 1.68 | 5.4 | 999.3 | 83.7 |
| 2251.48 | 1.92 | 6.0 | 848.5 | 78.6 |
| 2269.96 | 2.47 | 7.6 | 585.9 | 62.1 |
| 2302.30 | 2.00 | 6.1 | 814.6 | 78.8 |
| 2601.06 | 2.10 | 5.7 | 854.7 | 99.7 |
| 2722.72 | 1.83 | 4.7 | 1096.8 | 120.2 |
| 2761.22 | 2.60 | 6.6 | 658.6 | 87.1 |
| 3435.74 | 2.55 | 5.2 | 843.7 | 137.6 |
| 3501.96 | 2.96 | 5.9 | 687.7 | 123.1 |
| 3769.92 | 2.37 | 4.4 | 1035.4 | 178.4 |
| 4532.22 | 2.60 | 4.0 | 1081.1 | 234.8 |
| 4955.72 | 2.77 | 3.9 | 1076.9 | 263.8 |
| 6083.00 | 4.30 | 4.9 | 682.2 | 255.7 |
| 7830.90 | 3.99 | 3.6 | 981.9 | 456.5 |
| 8249.78 | 4.30 | 3.6 | 925.2 | 470.3 |
| 8599.36 | 4.84 | 3.9 | 807.2 | 453.8 |
| 8670.20 | 3.43 | 2.8 | 1362.9 | 650.6 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 8808.80 | 4.98 | 4.0 | 791.8 | 462.7 |
| 9089.08 | 3.56 | 2.7 | 1354.1 | 689.9 |
| 12375.44 | 5.70 | 3.2 | 909.4 | 798.4 |
| 17060.12 | 5.58 | 2.3 | 1296.0 | 1551.3 |
| 30763.04 | 12.51 | 2.8 | 695.3 | 2247.8 |
| 37405.06 | 12.90 | 2.4 | 807.3 | 3222.8 |
| 1087.24 | 1.63 | 10.5 | 524.9 | 21.6 |
| 1127.28 | 1.15 | 7.1 | 914.1 | 32.8 |
| 1178.10 | 1.44 | 8.6 | 680.6 | 28.6 |
| 1182.72 | 1.65 | 9.8 | 558.0 | 25.2 |
| 1201.20 | 1.62 | 9.4 | 584.4 | 26.5 |
| 1210.44 | 1.48 | 8.5 | 675.7 | 29.5 |
| 1225.84 | 1.57 | 9.9 | 625.1 | 28.5 |
| 1239.16 | 1.76 | 9.9 | 531.0 | 25.9 |
| 1242.78 | 1.83 | 10.3 | 504.1 | 25.1 |
| 1248.94 | 1.43 | 8.0 | 727.8 | 32.3 |
| 1256.64 | 1.15 | 6.4 | 1019.0 | 40.8 |
| 1262.80 | 1.42 | 7.9 | 748.9 | 33.4 |
| 1301.30 | 1.67 | 9.0 | 604.8 | 30.2 |
| 1358.28 | 1.72 | 8.8 | 603.9 | 31.9 |
| 1416.60 | 1.83 | 9.1 | 570.8 | 32.5 |
| 1504.58 | 1.93 | 9.0 | 559.7 | 34.8 |
| 1524.60 | 2.40 | 11.0 | 410.1 | 28.8 |
| 1640.10 | 1.62 | 6.9 | 797.9 | 49.4 |
| 1660.12 | 1.62 | 6.8 | 807.6 | 50.7 |
| 1709.40 | 2.17 | 8.9 | 536.0 | 40.1 |
| 1720.18 | 1.68 | 6.9 | 787.6 | 52.2 |
| 1787.94 | 1.63 | 6.4 | 856.5 | 58.2 |
| 1846.46 | 1.50 | 5.7 | 1005.1 | 67.5 |
| 1849.54 | 1.30 | 6.8 | 765.9 | 56.5 |
| 1861.86 | 1.47 | 5.5 | 1048.2 | 70.2 |
| 1864 94 | 1.82 | 6.8 | 761.6 | 56.9 |
| 1897.28 | 2.13 | 7.9 | 608.9 | 50.1 |
| 2014.32 | 1.97 | 6.8 | 730.4 | 61.3 |
| 2263.80 | 2.57 | 7.9 | 550.5 | 59.3 |
| 2360.82 | 3.05 | 9.0 | 443.2 | 54.3 |
| 2450.14 | 2.10 | 6.0 | 805.1 | 84.9 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 2459.38 | 2.68 | 7.6 | 559.5 | 67.0 |
| 2467.08 | 2.27 | 6.4 | 722.9 | 79.8 |
| 2511.74 | 1.73 | 4.8 | 1100.7 | 108.2 |
| 2588.74 | 1.95 | 5.3 | 950.7 | 102.1 |
| 2687.30 | 1.86 | 4.8 | 1060.8 | 115.5 |
| 2711.94 | 3.18 | 8.2 | 477.5 | 68.7 |
| 3120.04 | 2.05 | 4.6 | 1063.0 | 141.1 |
| 3150.84 | 2.68 | 6.0 | 716.8 | 109.9 |
| 3238.62 | 2.03 | 4.4 | 1117.0 | 153.3 |
| 3465.00 | 2.72 | 5.5 | 773.8 | 131.3 |
| 4255.02 | 2.19 | 3.6 | 1311.4 | 245.5 |
| 4495.26 | 3.23 | 5.0 | 773.2 | 185.7 |
| 4641.56 | 2.16 | 3.3 | 1463.8 | 296.6 |
| 4797.10 | 4.08 | 6.0 | 581.4 | 167.5 |
| 5091.24 | 4.37 | 6.0 | 558.0 | 176.4 |
| 5249.86 | 4.37 | 5.8 | 575.3 | 187.5 |
| 5453.14 | 2.75 | 3.5 | 1195.8 | 321.3 |
| 5453.14 | 3.23 | 4.2 | 937.9 | 273.3 |
| 6323.14 | 3.00 | 3.4 | 1197.6 | 383.6 |
| 7060.90 | 3.35 | 3.3 | 1151.6 | 442.2 |
| 7481.32 | 5.47 | 5.1 | 585.3 | 304.2 |
| 7550.62 | 5.40 | 5.0 | 601.7 | 313.7 |
| 10207.12 | 4.78 | 3.3 | 975.7 | 647.2 |
| 11396.00 | 4.83 | 3.0 | 1072.5 | 798.4 |
| 14192.64 | 4.68 | 2.3 | 1400.3 | 1278.0 |
| 16360.96 | 5.47 | 2.3 | 1280.0 | 1455.0 |
| 25659.48 | 10.00 | 2.7 | 811.4 | 1956.4 |
| 28665.56 | 6.83 | 1.7 | 1604.8 | 3573.2 |
| 33419.54 | 11.07 | 2.3 | 907.8 | 2998.8 |
| 311.08 | .68 | 15.3 | 554.1 | 4.2 |
| 329.56 | .60 | 12.7 | 713.2 | 5.4 |
| 341.88 | .65 | 13.4 | 645.5 | 5.3 |
| 361.90 | .55 | 10.7 | 875.5 | 7.0 |
| 371.14 | .67 | 12.6 | 676.8 | 6.1 |
| 385.00 | .60 | 10.9 | 834.4 | 7.4 |
| 395.78 | .72 | 12.8 | 641.8 | 6.4 |
| 398.86 | .54 | 9.5 | 1001.1 | 8.7 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 408.10 | .60 | 10.3 | 883.0 | 8.3 |
| 414.26 | .68 | 11.4 | 744.8 | 7.5 |
| 460.46 | .63 | 9.5 | 925.1 | 10.0 |
| 469.70 | .65 | 9.7 | 895.2 | 10.1 |
| 491.26 | .72 | 10.3 | 802.4 | 9.9 |
| 514.36 | .69 | 9.4 | 891.0 | 11.3 |
| 552.86 | .69 | 8.8 | 954.2 | 13.1 |
| 583.66 | .80 | 9.6 | 817.5 | 12.7 |
| 588.28 | .72 | 8.6 | 955.5 | 14.2 |
| 606.76 | .78 | 9.0 | 879.8 | 14.0 |
| 609.84 | .77 | 8.8 | 906.9 | 14.4 |
| 622.16 | .74 | 8.3 | 976.2 | 15.5 |
| 622.16 | .82 | 9.2 | 842.7 | 14.1 |
| 403.48 | .79 | 13.6 | 578.3 | 6.1 |
| 417.34 | .74 | 12.4 | 660.0 | 7.0 |
| 426.58 | .81 | 13.3 | 587.1 | 6.7 |
| 437.36 | .75 | 12.0 | 675.1 | 7.6 |
| 443.52 | .70 | 11.1 | 756.2 | 8.3 |
| 469.70 | .73 | 10.9 | 750.8 | 9.0 |
| 472.78 | .82 | 12.1 | 637.2 | 8.1 |
| 472.78 | .85 | 12.5 | 607.0 | 7.8 |
| 478.94 | .73 | 10.7 | 764.2 | 9.3 |
| 491.26 | .75 | 10.6 | 763.2 | 9.6 |
| 491.26 | .86 | 12.2 | 619.4 | 8.4 |
| 492.80 | .87 | 12.3 | 608.6 | 8.3 |
| 494.34 | .76 | 10.8 | 742.7 | 9.5 |
| 503.58 | .77 | 10.7 | 750.1 | 9.8 |
| 543.62 | .90 | 11.6 | 634.3 | 9.7 |
| 557.48 | .96 | 12.1 | 591.1 | 9.6 |
| 568.26 | .85 | 10.5 | 723.5 | 11.3 |
| 579.04 | .92 | 11.1 | 660.8 | 10.9 |
| 591.36 | .84 | 9.9 | 768.0 | 12.4 |
| 620.62 | .92 | 10.4 | 705.9 | 12.5 |
| 625.24 | .91 | 10.2 | 716.6 | 12.7 |
| 669.90 | .95 | 10.0 | 720.1 | 14.0 |
| 716.10 | 1.02 | 10.0 | 694.6 | 14.9 |
| 725.34 | 1.03 | 10.0 | 689.5 | 15.1 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 729.96 | 1.01 | 9.6 | 724.3 | 15.8 |
| 729.96 | 1.27 | 12.2 | 509.9 | 12.5 |
| 751.52 | 1.17 | 10.9 | 594.4 | 14.4 |
| 759.22 | .99 | 9.1 | 776.5 | 17.4 |
| 820.82 | 1.04 | 8.8 | 777.1 | 19.3 |
| 833.14 | 1.18 | 9.9 | 653.3 | 17.5 |
| 839.30 | 1.08 | 9.0 | 752.7 | 19.5 |
| 865.48 | 1.16 | 9.3 | 697.0 | 19.3 |
| 928.62 | 1.15 | 8.6 | 756.6 | 22.4 |
| 1007.16 | 1.35 | 9.4 | 643.3 | 22.4 |
| 1067.22 | 1.18 | 7.7 | 836.2 | 28.8 |
| 462.00 | .84 | 12.8 | 596.3 | 7.5 |
| 545.16 | 1.02 | 13.0 | 533.0 | 8.7 |
| 592.90 | 1.03 | 12.2 | 567.3 | 10.1 |
| 617.54 | .95 | 10.8 | 666.9 | 11.9 |
| 654.50 | 1.34 | 14.4 | 419.8 | 9.5 |
| 654.50 | 1.15 | 12.3 | 530.7 | 11.1 |
| 722.26 | 1.14 | 11.0 | 594.8 | 13.6 |
| 811.58 | 1.26 | 10.8 | 576.1 | 15.6 |
| 848.54 | 1.21 | 9.9 | 641.5 | 17.8 |
| 868.56 | 1.14 | 9.2 | 710.5 | 19.6 |
| 939.40 | 1.21 | 9.0 | 706.3 | 21.7 |
| 957.88 | 1.27 | 9.3 | 665.8 | 21.4 |
| 960.96 | 1.25 | 9.1 | 687.0 | 21.9 |
| 984.06 | 1.17 | 8.3 | 773.9 | 24.5 |
| 1017.94 | 1.30 | 9.0 | 683.7 | 23.6 |

Total number of fragments = 734

Average ballistic density for all fragments = 755.0

Average gamma for all fragments = 10.010

Number of hazardous fragments in zone = 103

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 500 to 700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 309.54 | .60 | 13.6 | 661.1 | 4.7 |
| 311.08 | .56 | 12.7 | 734.4 | 5.1 |
| 312.62 | .66 | 14.7 | 587.0 | 4.4 |
| 317.24 | .55 | 12.2 | 771.4 | 5.4 |
| 320.32 | .55 | 12.0 | 787.5 | 5.6 |
| 320.32 | .66 | 14.5 | 594.7 | 4.6 |
| 321.86 | .58 | 12.6 | 728.7 | 5.3 |
| 328.02 | .56 | 11.9 | 787.0 | 5.7 |
| 328.02 | .59 | 12.7 | 718.3 | 5.4 |
| 329.56 | .85 | 18.0 | 421.3 | 3.8 |
| 331.10 | .52 | 10.9 | 893.3 | 6.3 |
| 331.10 | .64 | 13.4 | 654.3 | 5.1 |
| 332.64 | .66 | 13.8 | 626.1 | 5.0 |
| 334.18 | .67 | 14.1 | 605.3 | 4.9 |
| 335.72 | .62 | 12.9 | 691.0 | 5.4 |
| 335.72 | .57 | 11.8 | 786.3 | 5.9 |
| 337.26 | .57 | 11.8 | 783.7 | 5.9 |
| 337.26 | .65 | 13.4 | 649.6 | 5.2 |
| 340.34 | .79 | 16.2 | 487.5 | 4.4 |
| 340.34 | .56 | 11.5 | 818.7 | 6.2 |
| 341.88 | .55 | 11.3 | 838.2 | 6.3 |
| 344.96 | .58 | 11.8 | 774.9 | 6.1 |
| 352.66 | .64 | 12.8 | 684.0 | 5.7 |
| 354.20 | .71 | 14.0 | 592.1 | 5.3 |
| 354.20 | .78 | 15.4 | 513.2 | 4.8 |
| 355.74 | .75 | 14.7 | 548.8 | 5.0 |
| 357.28 | .91 | 17.0 | 412.3 | 4.2 |
| 357.28 | .49 | 9.5 | 1057.8 | 7.8 |
| 363.44 | .60 | 11.5 | 785.9 | 6.6 |
| 369.60 | .89 | 16.8 | 441.7 | 4.6 |
| 372.68 | .65 | 12.1 | 719.4 | 6.4 |
| 377.30 | .67 | 12.4 | 691.1 | 6.3 |
| 377.30 | .64 | 11.9 | 736.9 | 6.6 |
| 377.30 | .55 | 10.2 | 920.0 | 7.7 |
| 380.38 | .38 | 7.0 | 1604.8 | 11.2 |
| 383.46 | .64 | 11.6 | 754.2 | 6.9 |
| 383.46 | .50 | 9.1 | 1087.9 | 8.8 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 500 to 700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 385.00 | .60 | 11.0 | 820.2 | 7.3 |
| 385.00 | .78 | 14.2 | 556.7 | 5.6 |
| 385.00 | .71 | 12.9 | 644.9 | 6.2 |
| 389.62 | .76 | 13.6 | 590.4 | 6.0 |
| 391.16 | .89 | 15.9 | 465.1 | 5.1 |
| 398.86 | .97 | 17.0 | 417.5 | 4.9 |
| 400.40 | 1.09 | 19.0 | 353.3 | 4.4 |
| 400.40 | .69 | 12.1 | 694.1 | 6.9 |
| 400.40 | .79 | 13.7 | 575.7 | 6.1 |
| 401.94 | .81 | 14.1 | 554.4 | 5.9 |
| 406.56 | .87 | 14.9 | 503.6 | 5.7 |
| 406.56 | .74 | 12.7 | 640.0 | 6.6 |
| 408.10 | 1.06 | 18.2 | 373.9 | 4.7 |
| 408.10 | .93 | 15.9 | 464.5 | 5.3 |
| 409.64 | 1.02 | 17.4 | 397.7 | 4.9 |
| 411.18 | .68 | 11.5 | 739.8 | 7.4 |
| 417.34 | .57 | 9.6 | 969.8 | 9.1 |
| 420.42 | .62 | 10.3 | 869.6 | 8.5 |
| 421.96 | .78 | 12.9 | 614.9 | 6.8 |
| 435.82 | .72 | 11.5 | 716.3 | 7.9 |
| 438.90 | .66 | 10.5 | 824.2 | 8.7 |
| 446.60 | .77 | 12.0 | 666.2 | 7.7 |
| 425.76 | .77 | 11.8 | 675.3 | 8.0 |
| 457.38 | .71 | 10.9 | 766.1 | 8.8 |
| 466.62 | .81 | 12.8 | 589.2 | 7.6 |
| 469.70 | .92 | 13.6 | 536.6 | 7.2 |
| 477.40 | .69 | 10.1 | 836.6 | 9.8 |
| 480.48 | .74 | 10.7 | 762.5 | 9.3 |
| 489.72 | .83 | 11.8 | 651.2 | 8.6 |
| 500.50 | .87 | 12.2 | 615.7 | 8.5 |
| 505.12 | .92 | 12.7 | 577.1 | 8.3 |
| 509.74 | .68 | 9.3 | 915.1 | 11.4 |
| 514.36 | 1.00 | 13.6 | 512.8 | 7.8 |
| 515.90 | .83 | 11.3 | 677.4 | 9.5 |
| 522.06 | .80 | 10.7 | 732.3 | 10.1 |
| 523.60 | .77 | 10.3 | 774.9 | 10.6 |
| 528.22 | .70 | 9.3 | 901.9 | 11.8 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 500 to 700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 542.08 | .74 | 9.6 | 844.7 | 11.7 |
| 549.78 | .95 | 12.1 | 593.7 | 9.5 |
| 551.32 | 1.01 | 12.8 | 543.2 | 8.9 |
| 554.40 | .98 | 12.4 | 572.3 | 9.3 |
| 568.26 | 1.32 | 16.3 | 374.7 | 7.3 |
| 571.34 | .82 | 10.1 | 768.0 | 11.8 |
| 574.42 | .91 | 11.1 | 658.5 | 10.7 |
| 580.58 | 1.06 | 12.7 | 535.8 | 9.5 |
| 599.06 | 1.00 | 11.7 | 600.0 | 10.7 |
| 608.30 | .78 | 9.0 | 878.0 | 14.0 |
| 614.46 | .94 | 10.7 | 672.1 | 11.9 |
| 623.70 | .87 | 9.8 | 764.6 | 13.2 |
| 637.56 | .83 | 9.1 | 844.7 | 14.6 |
| 645.26 | .79 | 8.6 | 913.7 | 15.6 |
| 657.58 | 1.00 | 10.7 | 655.6 | 12.8 |
| 662.20 | .82 | 8.6 | 895.1 | 15.9 |
| 666.82 | .71 | 7.4 | 1119.3 | 18.7 |
| 668.36 | 1.74 | 18.2 | 291.4 | 7.6 |
| 693.00 | .86 | 8.6 | 876.6 | 16.7 |
| 694.54 | 1.03 | 10.4 | 666.4 | 13.9 |
| 702.24 | 1.26 | 12.5 | 499.5 | 11.7 |
| 716.10 | .98 | 9.6 | 734.8 | 15.5 |
| 728.42 | 1.01 | 9.7 | 723.0 | 15.7 |
| 742.28 | .99 | 9.3 | 755.8 | 16.6 |
| 783.86 | 1.06 | 9.5 | 716.2 | 17.2 |
| 796.18 | 1.28 | 11.2 | 551.1 | 14.7 |
| 797.72 | 1.21 | 10.6 | 598.6 | 15.6 |
| 797.72 | .96 | 8.4 | 850.8 | 19.7 |
| 839.30 | 1.08 | 9.0 | 752.0 | 19.5 |
| 843.92 | 1.34 | 11.1 | 545.9 | 15.8 |
| 848.54 | 1.05 | 8.7 | 785.3 | 20.3 |
| 867.02 | 1.21 | 9.7 | 654.6 | 18.5 |
| 867.02 | 1.08 | 8.7 | 773.6 | 20.7 |
| 876.26 | 1.02 | 8.1 | 853.1 | 22.4 |
| 877.80 | 1.16 | 9.2 | 705.3 | 19.8 |
| 894.74 | 1.01 | 7.9 | 886.7 | 23.6 |
| 897.82 | 1.14 | 8.9 | 734.7 | 21.0 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

ollection Zone: Azimuth: 90-95°
Range: 500 to 700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 908.60 | 1.22 | 9.4 | 671.0 | 20.0 |
| 916.30 | 1.20 | 9.2 | 695.3 | 20.8 |
| 922.46 | 1.54 | 11.7 | 483.2 | 16.4 |
| 942.48 | 1.35 | 10.0 | 600.9 | 19.6 |
| 951.72 | 1.30 | 9.6 | 642.1 | 20.7 |
| 960.96 | 1.29 | 9.4 | 656.6 | 21.3 |
| 997.92 | 1.53 | 10.7 | 527.3 | 19.3 |
| 1016.40 | 1.03 | 7.1 | 978.0 | 29.9 |
| 1081.08 | 1.65 | 10.7 | 509.1 | 21.0 |
| 1127.28 | 1.10 | 6.8 | 975.8 | 34.3 |
| 1173.48 | 1.09 | 6.5 | 1034.0 | 37.6 |
| 1210.44 | 1.40 | 8.1 | 729.9 | 31.1 |
| 1227.38 | 2.58 | 14.7 | 296.9 | 17.4 |
| 1281.28 | 2.07 | 11.3 | 429.6 | 23.5 |
| 1292.06 | 2.48 | 13.4 | 330.8 | 20.0 |
| 1349.04 | 2.04 | 10.6 | 461.6 | 26.5 |
| 1376.76 | 1.33 | 6.7 | 901.7 | 42.5 |
| 1378.30 | 1.62 | 8.2 | 668.5 | 34.8 |
| 1455.30 | 1.73 | 8.3 | 639.6 | 36.4 |
| 1478.40 | 1.93 | 9.1 | 551.4 | 33.7 |
| 1546.16 | 2.08 | 9.4 | 515.4 | 34.2 |
| 1569.26 | 1.71 | 7.6 | 701.8 | 42.8 |
| 1581.58 | 1.79 | 7.9 | 660.4 | 41.5 |
| 1609.30 | 2.13 | 9.3 | 517.7 | 36.1 |
| 1670.90 | 1.74 | 7.3 | 728.0 | 47.7 |
| 1673.98 | 1.92 | 8.0 | 629.2 | 43.4 |
| 1744.82 | 1.52 | 6.1 | 931.1 | 59.5 |
| 1794.00 | 2.03 | 7.9 | 620.3 | 47.1 |
| 1875.72 | 1.79 | 6.7 | 783.2 | 58.4 |
| 1891.88 | 2.26 | 8.4 | 553.9 | 46.6 |
| 1932.70 | 1.98 | 7.2 | 693.7 | 56.1 |
| 2119.04 | 2.08 | 6.9 | 706.9 | 64.2 |
| 2380.84 | 2.49 | 7.3 | 607.4 | 67.8 |
| 2711.94 | 4.81 | 12.4 | 257.5 | 45.5 |
| 2909.06 | 2.99 | 7.2 | 561.8 | 84.0 |
| 2910.60 | 2.75 | 6.6 | 636.8 | 91.4 |
| 3290.98 | 6.06 | 12.9 | 220.6 | 53.1 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 500 to 700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 5523.98 | 4.88 | 6.2 | 512.4 | 185.8 |
| 2665.74 | 5.60 | 14.7 | 201.2 | 37.7 |
| 3716.02 | 4.42 | 8.3 | 399.9 | 92.8 |
| 13564.32 | 10.01 | 5.2 | 428.3 | 546.2 |

Total number of fragments = 152

Average ballistic density for all fragments = 669.5

Average gamma for all fragments = 11.147

Number of hazardous fragments in zone = 9

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 700 to 900 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 312.62 | .58 | 12.9 | 711.4 | 5.0 |
| 318.78 | .62 | 13.5 | 659.4 | 4.9 |
| 323.40 | .58 | 12.6 | 726.5 | 5.3 |
| 331.10 | .53 | 11.3 | 850.9 | 6.1 |
| 331.10 | .77 | 16.2 | 494.8 | 4.3 |
| 340.34 | .87 | 7.9 | 419.4 | 4.0 |
| 343.42 | .51 | 10.4 | 942.9 | 6.9 |
| 349.58 | .72 | 14.3 | 578.2 | 5.1 |
| 349.58 | .72 | 14.3 | 578.2 | 5.1 |
| 351.12 | .83 | 16.6 | 461.0 | 4.4 |
| 361.90 | .68 | 13.1 | 648.3 | 5.7 |
| 366.52 | .98 | 18.7 | 377.8 | 4.1 |
| 368.06 | .75 | 14.2 | 568.9 | 5.4 |
| 377.30 | .79 | 14.6 | 540.4 | 5.4 |
| 378.84 | .75 | 13.9 | 582.1 | 5.7 |
| 391.16 | .46 | 8.3 | 1241.6 | 9.8 |
| 392.70 | .64 | 11.4 | 770.6 | 7.2 |
| 392.70 | 1.01 | 18.1 | 384.6 | 4.5 |
| 397.32 | .78 | 13.7 | 579.0 | 6.0 |
| 397.32 | .81 | 14.3 | 543.0 | 5.8 |
| 398.86 | .65 | 11.4 | 757.6 | 7.3 |
| 400.40 | .99 | 17.3 | 405.9 | 4.8 |
| 401.94 | .78 | 13.6 | 581.2 | 6.1 |
| 411.18 | .63 | 10.6 | 832.2 | 8.0 |
| 411.18 | .56 | 9.5 | 983.8 | 9.0 |
| 411.18 | .98 | 16.6 | 425.8 | 5.1 |
| 412.72 | .96 | 16.4 | 436.1 | 5.3 |
| 415.80 | .75 | 12.5 | 646.6 | 6.9 |
| 417.34 | .61 | 10.2 | 880.3 | 8.5 |
| 428.12 | .83 | 13.5 | 569.3 | 6.6 |
| 431.20 | .65 | 10.5 | 832.4 | 8.6 |
| 440.44 | .78 | 12.4 | 638.1 | 7.4 |
| 440.44 | .56 | 8.9 | 1051.0 | 10.3 |
| 445.06 | 1.09 | 17.1 | 392.7 | 5.4 |
| 466.62 | .69 | 10.3 | 823.1 | 9.4 |
| 477.40 | .76 | 11.2 | 716.3 | 8.9 |
| 482.02 | .87 | 12.7 | 592.0 | 7.9 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 700 to 900 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 491.26 | .75 | 10.6 | 760.9 | 9.6 |
| 500.50 | .74 | 10.3 | 791.0 | 10.1 |
| 503.58 | .89 | 12.3 | 602.8 | 8.5 |
| 508.20 | .88 | 12.1 | 620.9 | 8.8 |
| 535.92 | .86 | 11.3 | 667.3 | 9.9 |
| 546.70 | 1.10 | 14.1 | 473.9 | 8.1 |
| 566.72 | .88 | 10.9 | 685.3 | 10.8 |
| 572.88 | .82 | 10.1 | 767.3 | 11.8 |
| 574.42 | .86 | 10.5 | 719.0 | 11.4 |
| 588.28 | .02 | 12.1 | 571.1 | 10.1 |
| 592.90 | .94 | 11.0 | 655.8 | 11.2 |
| 600.60 | 1.24 | 14.4 | 437.1 | 8.7 |
| 609.84 | .80 | 9.2 | 852.3 | 13.8 |
| 619.08 | 1.03 | 11.6 | 595.7 | 11.1 |
| 620.62 | 1.11 | 12.5 | 530.0 | 10.3 |
| 623.70 | .75 | 8.4 | 958.9 | 15.4 |
| 629.86 | .95 | 10.5 | 685.2 | 12.5 |
| 632.94 | .70 | 7.8 | 1076.1 | 17.0 |
| 637.56 | 1.14 | 12.5 | 526.6 | 10.6 |
| 639.10 | .86 | 9.4 | 799.8 | 14.1 |
| 652.96 | .92 | 9.9 | 740.4 | 13.8 |
| 662.20 | 1.02 | 10.8 | 642.8 | 12.8 |
| 680.68 | 1.36 | 13.9 | 431.1 | 10.2 |
| 682.22 | 1.17 | 12.0 | 539.1 | 11.8 |
| 696.08 | 1.00 | 10.0 | 699.2 | 14.4 |
| 703.78 | 1.00 | 9.9 | 704.8 | 14.7 |
| 717.64 | 1.07 | 10.4 | 648.4 | 14.3 |
| 745.36 | 1.00 | 9.4 | 747.6 | 16.5 |
| 748.44 | 1.36 | 12.7 | 470.3 | 12.2 |
| 762.30 | 1.08 | 9.9 | 683.9 | 16.1 |
| 770.00 | .95 | 8.7 | 827.7 | 18.5 |
| 773.08 | 1.35 | 12 | 492.9 | 13.2 |
| 788.48 | .87 | 7.7 | 976.7 | 21.3 |
| 791.56 | 1.44 | 12.8 | 456.2 | 12.9 |
| 793.10 | 1.21 | 10.7 | 598.1 | 15.5 |
| 797.72 | 1.26 | 11.1 | 562.0 | 15.0 |
| 806.96 | 1.30 | 11.3 | 546.3 | 14.9 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 700 to 900 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 823.90 | 1.29 | 10.9 | 563.6 | 15.7 |
| 856.24 | 1.37 | 11.2 | 536.9 | 16.0 |
| 871.64 | 1.02 | 8.2 | 844.9 | 22.1 |
| 883.96 | 1.06 | 8.4 | 806.6 | 21.8 |
| 885.50 | 1.26 | 10.0 | 626.1 | 18.5 |
| 890.12 | 1.43 | 11.3 | 519.4 | 16.4 |
| 893.20 | 1.18 | 9.3 | 695.9 | 20.1 |
| 902.44 | 1.07 | 8.3 | 818.8 | 22.7 |
| 914.76 | 1.15 | 8.8 | 746.6 | 21.7 |
| 920.92 | 1.16 | 8.8 | 733.3 | 21.6 |
| 931.70 | 1.21 | 9.1 | 702.6 | 21.4 |
| 953.26 | 1.12 | 8.2 | 800.7 | 24.2 |
| 956.34 | 1.56 | 11.4 | 489.9 | 17.4 |
| 977.90 | 1.14 | 8.2 | 801.3 | 24.9 |
| 987.14 | 1.28 | 9.1 | 684.1 | 22.7 |
| 1037.96 | 1.14 | 7.7 | 848.3 | 28.0 |
| 1048.74 | 1.49 | 9.9 | 577.8 | 22.0 |
| 1057.98 | 1.09 | 7.2 | 927.1 | 30.5 |
| 1071.84 | 1.27 | 8.3 | 748.9 | 26.9 |
| 1167.32 | 1.45 | 8.7 | 668.6 | 27.9 |
| 1198.12 | 1.44 | 8.4 | 697.0 | 29.7 |
| 1199.66 | 1.37 | 8.0 | 748.1 | 31.2 |
| 1213.52 | 2.32 | 13.4 | 343.9 | 18.9 |
| 1304.38 | 2.43 | 13.0 | 344.1 | 20.8 |
| 1361.36 | 1.67 | 8.6 | 630.8 | 33.0 |
| 1369.06 | 1.24 | 6.3 | 890.3 | 44.9 |
| 1395.24 | 1.91 | 9.6 | 528.6 | 30.3 |
| 1478.70 | 1.69 | 8.0 | 647.7 | 38.3 |
| 1515.36 | 1.99 | 9.2 | 539.8 | 34.3 |
| 1555.40 | 1.67 | 7.5 | 720.1 | 43.0 |
| 1580.04 | 1.85 | 8.2 | 628.9 | 40.1 |
| 1781.78 | 1.55 | 6.1 | 926.9 | 61.0 |
| 1806.42 | 1.84 | 7.1 | 723.8 | 52.7 |
| 1820.26 | 2.36 | 9.1 | 502.1 | 41.7 |
| 1875.72 | 2.00 | 7.4 | 665.2 | 52.4 |
| 1888.04 | 3.85 | 14.3 | 249.9 | 27.5 |
| 1966.58 | 2.37 | 8.4 | 539.0 | 48.5 |
| 2163.70 | 2.83 | 9.2 | 454.5 | 49.5 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 700 to 900 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 2251.48 | 2.07 | 6.4 | 756.5 | 72.8 |
| 2256.10 | 1.92 | 6.0 | 846.0 | 78.7 |
| 2356.20 | 2.20 | 6.5 | 724.0 | 75.1 |
| 2374.68 | 2.56 | 7.5 | 579.8 | 65.5 |
| 2427.04 | 2.13 | 6.1 | 780.2 | 82.1 |
| 2579.50 | 2.59 | 7.0 | 619.2 | 76.4 |
| 2718.10 | 3.25 | 8.4 | 463.9 | 67.5 |
| 2735.04 | 2.97 | 7.6 | 534.4 | 74.8 |
| 4164.16 | 2.81 | 4.7 | 885.4 | 183.6 |
| 6152.30 | 4.60 | 5.2 | 623.6 | 244.5 |
| 1920.38 | 3.15 | 11.5 | 343.5 | 34.8 |
| 5383.84 | 5.80 | 7.5 | 385.4 | 148.5 |
| 6851.46 | 6.46 | 6.6 | 417.3 | 215.9 |
| 8530.06 | 6.17 | 5.1 | 556.6 | 350.4 |
| 19716.62 | 15.08 | 5.4 | 336.7 | 766.0 |
| 27057.80 | 14.74 | 3.8 | 478.1 | 1475.9 |
| 27476.68 | 12.84 | 3.3 | 597.2 | 1747.1 |
| 34118.70 | 14.92 | 3.1 | 592.0 | 2318.4 |
| 58170.42 | 21.18 | 2.5 | 596.8 | 4747.3 |

Total number of fragments = 131

Average ballistic density for all fragments = 648.4

Average gamma for all fragments = 10.375

Number of hazardous fragments in zone = 19

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 900 to 1100 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 309.54 | .80 | 18.1 | 433.4 | 3.6 |
| 311.08 | .69 | 15.5 | 543.9 | 4.2 |
| 317.24 | .55 | 12.0 | 786.3 | 5.5 |
| 321.86 | .53 | 11.5 | 841.3 | 5.8 |
| 323.40 | .59 | 12.8 | 711.8 | 5.3 |
| 324.94 | .69 | 14.8 | 568.2 | 4.6 |
| 329.56 | .86 | 18.2 | 416.1 | 3.8 |
| 334.18 | .57 | 11.9 | 780.7 | 5.8 |
| 341.88 | .82 | 16.7 | 462.1 | 4.2 |
| 343.42 | .81 | 16.4 | 473.7 | 4.3 |
| 344.96 | .86 | 17.5 | 431.8 | 4.1 |
| 346.50 | .62 | 12.6 | 704 6 | 5.7 |
| 349.58 | .58 | 11.6 | 793.5 | 6.3 |
| 352.66 | .88 | 17.4 | 429.4 | 4.2 |
| 355.74 | .56 | 11.1 | 839.9 | 6.7 |
| 358.82 | .62 | 12.1 | 738.5 | 6.2 |
| 360.36 | .74 | 14.3 | 570.7 | 5.2 |
| 360.36 | .69 | 13.4 | 630.1 | 5.6 |
| 363.44 | .88 | 16.9 | 441.8 | 4.5 |
| 364.98 | .64 | 12.2 | 719.6 | 6.2 |
| 364.98 | .73 | 13.9 | 591.2 | 5.5 |
| 368.06 | .75 | 14.3 | 566.7 | 5.4 |
| 369.60 | .70 | 13.2 | 635.2 | 5.8 |
| 378.84 | .82 | 15.2 | 507.4 | 5.2 |
| 380.38 | .89 | 16.3 | 455.3 | 4.8 |
| 381.92 | .69 | 12.6 | 673.7 | 6.3 |
| 383.46 | .64 | 11.7 | 745.4 | 6.8 |
| 392.70 | .75 | 13.4 | 605.8 | 6.1 |
| 406.56 | .67 | 11.5 | 744.7 | 7.4 |
| 408.10 | .71 | 12.2 | 682.1 | 7.0 |
| 408.10 | .63 | 10.8 | 816.1 | 7.9 |
| 408.10 | .84 | 14.3 | 533.9 | 5.9 |
| 420.42 | .81 | 13.5 | 574.6 | 6.5 |
| 440.44 | 1.58 | 25.0 | 222.8 | 3.7 |
| 441.98 | .70 | 11.1 | 754.7 | 8.3 |
| 441.98 | .83 | 13.1 | 587.7 | 7.0 |
| 443.52 | .69 | 11.0 | 767.1 | 8.4 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 900 to 1100 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 446.60 | .72 | 11.3 | 725.0 | 8.2 |
| 446.60 | .64 | 10.1 | 868.2 | 9.2 |
| 448.14 | .90 | 14.1 | 522.3 | 6.6 |
| 452.76 | .91 | 14.0 | 523.3 | 6.7 |
| 465.08 | .76 | 11.4 | 707.5 | 8.5 |
| 472.78 | .86 | 12.7 | 598.0 | 7.8 |
| 475.86 | .87 | 12.8 | 589.5 | 7.8 |
| 480.48 | .92 | 13.4 | 543.6 | 7.4 |
| 485.10 | .94 | 13.5 | 533.1 | 7.4 |
| 488.18 | .63 | 9.0 | 988.0 | 11.3 |
| 494.34 | .79 | 11.1 | 710.8 | 9.3 |
| 495.88 | .86 | 12.2 | 619.6 | 8.5 |
| 498.96 | .87 | 12.2 | 618.1 | 8.5 |
| 502.04 | .97 | 13.5 | 526.3 | 7.7 |
| 511.28 | 1.07 | 14.6 | 461.9 | 7.3 |
| 512.82 | 1.00 | 13.6 | 516.7 | 7.9 |
| 520.52 | .67 | 9.1 | 940.7 | 11.9 |
| 523.60 | .86 | 11.6 | 652.0 | 9.4 |
| 526.68 | .76 | 10.2 | 788.7 | 10.8 |
| 532.84 | 1.13 | 14.8 | 443.6 | 7.5 |
| 562.10 | 1.10 | 13.7 | 487.2 | 8.5 |
| 575.96 | .91 | 11.1 | 661.3 | 10.8 |
| 585.20 | .83 | 10.0 | 771.1 | 12.2 |
| 600.60 | 1.05 | 12.2 | 558.2 | 10.2 |
| 609.84 | .80 | 9.2 | 850.7 | 13.8 |
| 628.32 | .85 | 9.5 | 796.1 | 13.7 |
| 649.88 | .81 | 8.8 | 884.9 | 15.4 |
| 662.20 | .94 | 9.9 | 726.6 | 13.9 |
| 662.20 | .89 | 9.4 | 787.4 | 14.6 |
| 665.28 | 1.21 | 12.7 | 499.2 | 10.9 |
| 671.44 | .95 | 9.9 | 726.3 | 14.1 |
| 722.26 | 1.06 | 10.3 | 663.7 | 14.7 |
| 733.04 | .99 | 9.4 | 747.6 | 16.2 |
| 742.28 | 1.02 | 9.6 | 718.4 | 16.0 |
| 742.28 | 1.02 | 9.6 | 719.5 | 16.0 |
| 749.98 | .99 | 9.3 | 756.8 | 16.8 |
| 759.22 | .95 | 8.7 | 826.5 | 18.1 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 900 to 1100 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 793.10 | 1.23 | 10.8 | 582.8 | 15.2 |
| 805.42 | 1.20 | 10.5 | 609.7 | 16.0 |
| 817.74 | 1.18 | 10.1 | 641.2 | 16.9 |
| 823.90 | 1.12 | 9.5 | 699.8 | 18.1 |
| 868.56 | 1.28 | 10.3 | 602.6 | 17.6 |
| 873.18 | 1.35 | 10.9 | 554.2 | 16.7 |
| 882.42 | 1.25 | 9.9 | 628.4 | 18.5 |
| 883.96 | 1.19 | 9.4 | 680.9 | 19.5 |
| 890.12 | 1.24 | 9.8 | 644.6 | 19.0 |
| 911.68 | 1.38 | 10.6 | 562.4 | 17.9 |
| 914.76 | 1.23 | 9.4 | 670.6 | 20.2 |
| 914.76 | 1.42 | 10.9 | 541.7 | 17.5 |
| 944.02 | 1.36 | 10.3 | 576.0 | 19.1 |
| 950.18 | 1.21 | 8.9 | 713.9 | 22.2 |
| 967.12 | 1.50 | 10.9 | 526.4 | 18.5 |
| 968.66 | 1.33 | 9.6 | 631.5 | 21.0 |
| 996.38 | 1.34 | 9.4 | 642.3 | 22.0 |
| 1001.00 | 1.36 | 9.5 | 631.1 | 21.9 |
| 1019.48 | 1.09 | 7.5 | 895.9 | 28.3 |
| 1070.30 | 2.16 | 14.1 | 337.2 | 15.8 |
| 1124.20 | 1.51 | 9.4 | 605.9 | 24.9 |
| 1164.24 | 1.30 | 7.8 | 785.5 | 31.0 |
| 1182.72 | 1.22 | 7.2 | 877.7 | 34.1 |
| 1216.60 | 1.30 | 7.5 | 820.8 | 33.8 |
| 1265.88 | 1.76 | 9.7 | 542.2 | 27.1 |
| 1299.76 | 2.04 | 11.0 | 446.1 | 24.6 |
| 1301.30 | 1.45 | 7.8 | 745.3 | 34.7 |
| 1336.72 | 1.51 | 7.9 | 720.4 | 35.2 |
| 1355.20 | 2.66 | 13.7 | 312.4 | 20.5 |
| 1378.30 | 1.76 | 8.9 | 590.3 | 32.1 |
| 1402.94 | 1.53 | 7.6 | 741.3 | 38.2 |
| 1483.02 | 1.71 | 8.1 | 663.2 | 38.2 |
| 1503.04 | 1.69 | 7.9 | 681.1 | 39.7 |
| 1540.00 | 1.81 | 8.2 | 632.4 | 38.9 |
| 1583.12 | 1.81 | 8.0 | 670.1 | 41.1 |
| 1618.54 | 2.08 | 9.0 | 539.5 | 37.4 |
| 1635.48 | 1.92 | 8.2 | 614.7 | 41.4 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 900 to 1100 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 1638.56 | 1.63 | 7.0 | 787.4 | 35.2 |
| 1694.00 | 1.92 | 7.9 | 636.7 | 44.4 |
| 1795.64 | 3.39 | 13.2 | 287.7 | 28.3 |
| 1848.00 | 3.91 | 14.8 | 239.0 | 26.0 |
| 1971.20 | 1.65 | 5.9 | 930.0 | 70.0 |
| 2139.06 | 2.33 | 7.6 | 601.4 | 58.4 |
| 2283.82 | 2.30 | 7.0 | 654.7 | 67.4 |
| 2721.18 | 2.89 | 7.4 | 553.9 | 76.1 |
| 2955.26 | 4.56 | 10.8 | 303.5 | 56.9 |
| 3213.98 | 3.22 | 7.0 | 556.2 | 95.3 |
| 3592.82 | 3.56 | 6.9 | 534.9 | 107.7 |
| 4181.10 | 4.14 | 6.9 | 496.4 | 125.5 |
| 5453.14 | 3.59 | 4.6 | 801.7 | 246.1 |
| 5523.98 | 4.29 | 5.4 | 621.7 | 211.4 |
| 5593.28 | 4.64 | 5.8 | 559.6 | 200.3 |
| 1931.16 | 3.36 | 12.2 | 313.6 | 33.0 |
| 2343.88 | 3.46 | 10.3 | 364.2 | 47.2 |
| 4154.92 | 4.72 | 8.0 | 405.2 | 108.7 |
| 8320.62 | 6.26 | 5.3 | 531.2 | 328.6 |
| 8389.92 | 7.54 | 6.3 | 405.2 | 277.4 |
| 8670.20 | 6.36 | 5.1 | 540.6 | 351.2 |
| 9019.78 | 7.07 | 5.5 | 479.8 | 341.9 |
| 12654.18 | 8.83 | 4.9 | 482.3 | 538.9 |
| 13214.74 | 7.96 | 4.2 | 588.4 | 651.9 |
| 19017.46 | 10.33 | 3.8 | 572.8 | 1040.3 |
| 23771.44 | 13.14 | 3.9 | 499.1 | 1277.9 |

Total number of fragments = 137

Average ballistic density for all fragments = 619.9

Average for all fragments = 10.778

Number of hazardous fragments in zone = 19

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 304.92 | .54 | 12.4 | 770.6 | 5.1 |
| 308.00 | .50 | 11.4 | 863.4 | 5.6 |
| 314.16 | .62 | 13.8 | 642.0 | 4.7 |
| 318.78 | .49 | 10.7 | 938.0 | 6.2 |
| 318.78 | .50 | 10.9 | 907.1 | 6.1 |
| 321.86 | .48 | 10.4 | 977.0 | 6.5 |
| 324.94 | .48 | 10.2 | 992.6 | 6.6 |
| 329.56 | .60 | 12.8 | 707.3 | 5.4 |
| 337.26 | .50 | 10.4 | 948.2 | 6.7 |
| 337.26 | .51 | 10.7 | 915.2 | 6.6 |
| 341.88 | .72 | 14.6 | 565.5 | 4.9 |
| 344.96 | .65 | 13.2 | 659.8 | 5.4 |
| 346.50 | .70 | 14.1 | 596.7 | 5.1 |
| 348.04 | .54 | 10.8 | 889.4 | 6.7 |
| 348.04 | .56 | 11.2 | 832.7 | 6.4 |
| 348.04 | .61 | 12.3 | 723.4 | 5.9 |
| 349.58 | .51 | 10.2 | 965.5 | 7.1 |
| 351.12 | .71 | 14.1 | 590.6 | 5.2 |
| 352.66 | .52 | 10.3 | 943.2 | 7.1 |
| 358.82 | .57 | 11.0 | 842.7 | 6.8 |
| 368.06 | .61 | 11.6 | 768.8 | 6.6 |
| 374.22 | .75 | 14.1 | 573.9 | 5.5 |
| 375.76 | .59 | 11.0 | 825.0 | 7.1 |
| 377.30 | .56 | 10.4 | 895.5 | 7.5 |
| 381.92 | .61 | 11.1 | 805.6 | 7.1 |
| 385.00 | .59 | 10.7 | 847.4 | 7.5 |
| 386.54 | .65 | 11.7 | 744.5 | 6.9 |
| 395.78 | .59 | 10.4 | 882.3 | 7.9 |
| 398.86 | .70 | 12.3 | 682.5 | 6.8 |
| 398.86 | .68 | 12.0 | 705.1 | 6.9 |
| 400.40 | .74 | 13.0 | 625.2 | 6.4 |
| 405.02 | .58 | 10.1 | 912.2 | 8.4 |
| 411.18 | .72 | 12.2 | 677.3 | 7.0 |
| 411.18 | .56 | 9.4 | 994.5 | 9.1 |
| 412.72 | .63 | 10.7 | 825.4 | 8.0 |
| 414.26 | .74 | 12.5 | 652.1 | 6.9 |
| 423.50 | .63 | 10.4 | 842.9 | 8.4 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 425.04 | .76 | 12.5 | 645.3 | 7.1 |
| 426.58 | .68 | 11.2 | 755.7 | 7.9 |
| 431.20 | .65 | 10.6 | 817.2 | 8.5 |
| 435.82 | .66 | 10.7 | 805.5 | 8.5 |
| 438.90 | .74 | 11.8 | 688.1 | 7.7 |
| 438.90 | .77 | 12.3 | 645.8 | 7.4 |
| 440.44 | .75 | 11.9 | 680.8 | 7.7 |
| 441.98 | .67 | 10.7 | 798.8 | 8.6 |
| 445.06 | .61 | 9.6 | 929.6 | 9.6 |
| 449.68 | .84 | 13.1 | 585.1 | 7.2 |
| 451.22 | .71 | 11.0 | 754.2 | 8.5 |
| 455.84 | .87 | 13.3 | 562.7 | 7.1 |
| 460.46 | .76 | 11.6 | 695.0 | 8.3 |
| 465.08 | .89 | 13.4 | 551.1 | 7.2 |
| 469.70 | .77 | 11.5 | 692.5 | 8.5 |
| 469.70 | .98 | 14.6 | 485.6 | 6.7 |
| 469.70 | .68 | 10.1 | 845.1 | 9.7 |
| 475.86 | .72 | 10.6 | 777.3 | 9.3 |
| 488.18 | .71 | 10.2 | 810.9 | 9.9 |
| 492.80 | .94 | 13.4 | 539.9 | 7.7 |
| 505.12 | .91 | 12.7 | 578.1 | 8.3 |
| 509.74 | .76 | 10.4 | 769.4 | 10.2 |
| 511.28 | .80 | 11.0 | 713.2 | 9.7 |
| 512.82 | .96 | 13.0 | 548.6 | 8.2 |
| 517.44 | .63 | 8.5 | 1032.3 | 12.6 |
| 525.14 | .67 | 9.0 | 951.2 | 12.2 |
| 526.68 | .96 | 12.8 | 557.3 | 8.6 |
| 534.38 | .76 | 10.0 | 806.5 | 11.2 |
| 535.92 | .79 | 10.3 | 761.8 | 10.8 |
| 551.32 | .75 | 9.6 | 843.7 | 12.0 |
| 554.40 | .76 | 9.6 | 836.8 | 12.0 |
| 569.80 | .71 | 8.7 | 948.4 | 13.5 |
| 574.42 | .78 | 9.5 | 835.5 | 12.6 |
| 575.96 | .98 | 11.9 | 596.4 | 10.1 |
| 585.20 | .95 | 11.4 | 629.0 | 10.7 |
| 595.98 | .96 | 11.3 | 634.6 | 11.0 |
| 600.60 | .90 | 10.4 | 709.3 | 12.0 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 609.84 | .98 | 11.2 | 632.5 | 11.3 |
| 619.08 | .88 | 10.0 | 746.1 | 12.9 |
| 634.48 | 1.14 | 12.6 | 522.0 | 10.5 |
| 636.02 | .99 | 10.9 | 644.7 | 12.1 |
| 639.10 | .83 | 9.1 | 848.2 | 14.7 |
| 640.64 | .97 | 10.6 | 674.8 | 12.6 |
| 642.18 | .78 | 8.5 | 935.8 | 15.8 |
| 648.34 | .97 | 10.5 | 680.8 | 12.9 |
| 657.58 | .95 | 10.1 | 713.5 | 13.6 |
| 663.74 | 1.07 | 11.3 | 597.2 | 12.2 |
| 669.90 | 1.01 | 10.5 | 661.0 | 13.2 |
| 671.44 | .96 | 10.0 | 718.3 | 14.0 |
| 682.22 | .80 | 8.2 | 960.6 | 17.4 |
| 683.76 | .85 | 8.7 | 878.7 | 16.4 |
| 686.84 | 1.00 | 10.2 | 688.9 | 14.0 |
| 688.38 | .96 | 9.7 | 735.3 | 14.7 |
| 693.00 | .94 | 9.5 | 761.6 | 15.2 |
| 708.40 | .92 | 9.1 | 805.4 | 16.2 |
| 711.48 | .92 | 9.0 | 808.9 | 16.4 |
| 711.48 | 1.18 | 11.6 | 552.9 | 12.7 |
| 725.34 | .99 | 9.6 | 733.0 | 15.7 |
| 725.34 | 1.07 | 10.3 | 654.4 | 14.6 |
| 740.74 | 1.09 | 10.3 | 647.4 | 14.9 |
| 742.28 | 1.24 | 11.7 | 540.2 | 13.2 |
| 746.90 | 1.06 | 10.0 | 682.5 | 15.6 |
| 748.44 | .96 | 9.0 | 799.4 | 17.4 |
| 756.14 | 1.33 | 12.3 | 494.1 | 12.8 |
| 765.38 | .86 | 7.9 | 954.7 | 20.2 |
| 766.92 | 1.06 | 9.7 | 698.8 | 16.4 |
| 776.16 | .91 | 8.2 | 892.6 | 19.6 |
| 780.78 | .99 | 8.9 | 787.9 | 18.2 |
| 799.26 | .96 | 8.4 | 848.4 | 19.8 |
| 820.82 | 1.18 | 10.1 | 638.7 | 16.9 |
| 823.90 | 1.30 | 11.3 | 535.9 | 15.1 |
| 825.44 | 1.12 | 9.5 | 697.3 | 18.1 |
| 845.46 | 1.12 | 9.3 | 710.4 | 18.9 |
| 860.86 | 1.12 | 9.1 | 728.2 | 19.7 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 862.40 | .99 | 8.1 | 870.2 | 22.2 |
| 879.34 | 1.16 | 9.3 | 701.1 | 19.8 |
| 880.88 | 1.08 | 8.6 | 783.8 | 21.3 |
| 885.50 | 1.26 | 10.0 | 625.3 | 18.5 |
| 908.60 | 1.28 | 9.9 | 626.0 | 19.1 |
| 930.16 | 1.23 | 9.2 | 686.0 | 21.0 |
| 940.94 | 1.19 | 8.8 | 726.7 | 22.1 |
| 954.80 | 1.38 | 10.1 | 590.3 | 19.7 |
| 971.74 | 1.38 | 9.9 | 598.8 | 20.3 |
| 973.28 | 1.49 | 10.7 | 534.6 | 18.9 |
| 976.36 | 1.29 | 9.2 | 666.4 | 22.0 |
| 976.36 | 1.28 | 9.2 | 671.8 | 22.1 |
| 991.76 | 1.43 | 10.1 | 580.6 | 20.5 |
| 1044.12 | 1.26 | 8.4 | 740.0 | 25.8 |
| 1124.20 | 1.37 | 8.5 | 701.1 | 27.4 |
| 1125.74 | 1.38 | 8.6 | 694.4 | 27.3 |
| 1127.28 | 1.24 | 7.7 | 816.4 | 30.5 |
| 1179.64 | 1.61 | 9.6 | 577.4 | 25.7 |
| 1258.18 | 1.24 | 6.9 | 911.2 | 37.9 |
| 1272.04 | 1.58 | 8.7 | 640.5 | 30.4 |
| 1292.06 | 1.24 | 6.7 | 935.7 | 40.0 |
| 1302.84 | 1.45 | 7.8 | 746.2 | 34.8 |
| 1312.08 | 1.37 | 7.3 | 818.2 | 37.3 |
| 1316.70 | 1.68 | 8.9 | 604.7 | 30.7 |
| 1376.76 | 1.83 | 9.3 | 556.1 | 30.8 |
| 1378.30 | 1.74 | 8.8 | 600.5 | 32.4 |
| 1381.38 | 1.77 | 9.0 | 586.6 | 32.0 |
| 1392.16 | 1.68 | 8.4 | 639.3 | 34.3 |
| 1439.90 | 1.59 | 7.7 | 718.2 | 38.7 |
| 1496.88 | 1.34 | 6.3 | 965.0 | 49.7 |
| 1498.42 | 1.75 | 8.2 | 647.3 | 38.1 |
| 1512.28 | 1.70 | 7.9 | 682.3 | 40.0 |
| 1519.98 | 1.52 | 7.0 | 811.1 | 45.2 |
| 1550.78 | 2.28 | 10.3 | 450.5 | 31.3 |
| 1555.40 | 1.42 | 6.4 | 919.2 | 50.6 |
| 1580.04 | 1.42 | 6.3 | 933.8 | 52.2 |
| 1603.14 | 1.36 | 5.9 | 1010.8 | 56.2 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 1617.00 | 1.81 | 7.8 | 664.0 | 42.9 |
| 1617.00 | 2.01 | 8.7 | 567.4 | 38.7 |
| 1687.84 | 1.41 | 5.8 | 1008.1 | 60.0 |
| 1687.84 | 2.08 | 8.6 | 562.6 | 40.7 |
| 1710.94 | 2.06 | 8.4 | 578.7 | 42.2 |
| 1794.10 | 1.86 | 7.3 | 707.3 | 51.4 |
| 1798.72 | 1.64 | 6.4 | 856.4 | 58.6 |
| 1826.44 | 1.53 | 5.9 | 965.1 | 64.8 |
| 1875.72 | 1.87 | 7.0 | 733.5 | 55.9 |
| 2014.32 | 2.21 | 7.7 | 613.1 | 54.6 |
| 2111.34 | 2.33 | 7.7 | 593.6 | 56.8 |
| 2192.96 | 2.04 | 6.5 | 752.6 | 70.0 |
| 2202.20 | 2.19 | 7.0 | 679.5 | 65.8 |
| 2212.98 | 2.37 | 7.5 | 606.5 | 61.4 |
| 2274.58 | 2.90 | 8.9 | 460.6 | 53.0 |
| 2282.28 | 2.71 | 8.3 | 511.6 | 57.1 |
| 2289.98 | 2.54 | 7.8 | 565.7 | 61.3 |
| 2336.18 | 2.24 | 6.7 | 696.8 | 72.4 |
| 2337.72 | 2.42 | 7.2 | 621.0 | 67.1 |
| 2370.06 | 2.49 | 7.4 | 603.2 | 67.0 |
| 2585.66 | 2.86 | 7.7 | 534.6 | 69.5 |
| 2594.90 | 2.44 | 6.6 | 680.8 | 82.0 |
| 2704.24 | 2.12 | 5.5 | 876.1 | 102.5 |
| 2708.86 | 2.93 | 7.6 | 540.1 | 74.4 |
| 2711.94 | 2.39 | 6.2 | 734.0 | 91.4 |
| 2742.74 | 3.12 | 8.0 | 497.7 | 71.6 |
| 2778.16 | 2.68 | 6.8 | 633.2 | 85.6 |
| 2825.90 | 2.99 | 7.4 | 546.6 | 79.4 |
| 2861.32 | 2.45 | 6.0 | 746.1 | 99.3 |
| 2895.20 | 2.27 | 5.5 | 846.5 | 109.7 |
| 3218.60 | 3.47 | 7.5 | 497.9 | 88.7 |
| 3255.56 | 2.91 | 6.3 | 655.8 | 108.2 |
| 3317.16 | 2.87 | 6.1 | 682.3 | 113.9 |
| 3354.12 | 2.93 | 6.1 | 668.8 | 114.1 |
| 3411.10 | 3.16 | 6.5 | 607.2 | 109.4 |
| 3497.34 | 2.50 | 5.0 | 884.8 | 145.4 |
| 3808.42 | 2.43 | 4.5 | 1005.4 | 177.4 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 3967.04 | 3.57 | 6.3 | 588.1 | 131.0 |
| 3968.58 | 2.98 | 5.3 | 771.5 | 157.0 |
| 3999.38 | 3.82 | 6.7 | 535.7 | 124.4 |
| 4096.40 | 2.88 | 4.9 | 838.1 | 173.1 |
| 4185.72 | 3.91 | 6.5 | 541.4 | 133.1 |
| 4231.92 | 4.22 | 7.0 | 488.2 | 126.1 |
| 4797.10 | 3.66 | 5.3 | 685.1 | 186.8 |
| 5383.84 | 4.38 | 5.7 | 587.3 | 196.6 |
| 5523.98 | 3.82 | 4.8 | 739.9 | 237.4 |
| 9578.80 | 6.73 | 4.9 | 548.6 | 405.1 |
| 7410.48 | 5.28 | 5.0 | 610.8 | 309.0 |
| 11745.58 | 7.03 | 4.2 | 630.1 | 583.1 |
| 27868.12 | 10.17 | 2.6 | 853.7 | 2239.6 |
| 6501.88 | 5.63 | 6.1 | 486.7 | 223.1 |
| 12725.02 | 6.83 | 3.8 | 712.9 | 704.5 |
| 6223.14 | 5.50 | 6.2 | 482.5 | 209.2 |
| 7760.06 | 5.80 | 5.2 | 555.5 | 308.5 |
| 9857.54 | 7.67 | 5.4 | 464.1 | 376.4 |
| 24261.16 | 12.83 | 3.7 | 527.9 | 1363.2 |
| 7621.46 | 5.56 | 5.1 | 581.3 | 310.4 |
| 6292.44 | 5.38 | 6.0 | 504.2 | 218.7 |
| 7690.76 | 6.01 | 5.5 | 522.0 | 292.4 |
| | 35.79 | 2.3 | 504.5 | 9687.5 |
| 3404.94 | 3.95 | 8.1 | 433.7 | 87.2 |
| 6223.14 | 5.23 | 5.9 | 520.3 | 220.0 |
| 7341.18 | 6.08 | 5.8 | 489.7 | 263.4 |
| 6292.44 | 5.56 | 6.2 | 480.0 | 211.6 |
| 7690.76 | 6.01 | 5.5 | 522.0 | 292.4 |
| 22862.84 | 15.42 | 4.7 | 377.6 | 1007.3 |

Total number of fragments = 215

Average ballistic density for all fragments = 705.5

Average gamma for all fragments = 9.047

Number of hazardous fragments in zone = 56

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1500 to 1900 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 329.56 | .53 | 11.2 | 863.9 | 6.1 |
| 331.10 | .55 | 11.6 | 816.2 | 5.9 |
| 355.74 | .57 | 11.2 | 828.8 | 6.6 |
| 420.42 | .61 | 10.2 | 876.0 | 8.6 |
| 423.50 | .66 | 10.9 | 788.0 | 8.1 |
| 428.12 | .87 | 14.3 | 525.8 | 6.2 |
| 438.90 | .77 | 12.3 | 648.3 | 7.4 |
| 478.94 | .66 | 9.6 | 893.2 | 10.3 |
| 480.48 | .66 | 9.6 | 892.0 | 10.4 |
| 515.90 | .77 | 10.4 | 771.0 | 10.3 |
| 532.84 | .71 | 9.3 | 892.5 | 11.9 |
| 568.26 | .80 | 9.8 | 801.7 | 12.1 |
| 611.38 | .81 | 9.3 | 840.7 | 13.7 |
| 614.46 | .83 | 9.4 | 818.5 | 13.6 |
| 700.70 | .94 | 9.4 | 772.5 | 15.6 |
| 705.32 | 1.17 | 11.6 | 557.3 | 12.6 |
| 714.56 | 1.00 | 9.8 | 715.6 | 15.2 |
| 722.26 | .97 | 9.4 | 757.2 | 16.0 |
| 739.20 | 1.21 | 11.5 | 555.4 | 13.4 |
| 806.96 | 1.15 | 9.9 | 656.9 | 16.9 |
| 825.44 | .95 | 8.1 | 888.6 | 21.3 |
| 860.86 | 1.06 | 8.6 | 785.5 | 20.7 |
| 867.02 | 1.06 | 8.5 | 796.7 | 21.1 |
| 914.76 | 1.19 | 9.1 | 703.8 | 20.9 |
| 951.72 | 1.13 | 8.3 | 792.3 | 23.8 |
| 976.36 | 1.14 | 8.1 | 806.4 | 24.9 |
| 1067.22 | 1.17 | 7.7 | 840.1 | 28.9 |
| 1070.30 | 1.33 | 8.7 | 699.4 | 25.6 |
| 1088.78 | 1.24 | 8.0 | 784.7 | 28.3 |
| 1118.04 | 1.36 | 8.5 | 704.9 | 27.3 |
| 1127.28 | 1.26 | 7.8 | 794.2 | 29.9 |
| 1153.46 | 1.27 | 7.7 | 805.9 | 31.1 |
| 1156.54 | 1.48 | 9.0 | 642.3 | 26.9 |
| 1164.24 | 1.36 | 8.1 | 738.1 | 29.7 |
| 1168.86 | 1.67 | 10.0 | 541.6 | 24.3 |
| 1235.08 | 1.49 | 8.4 | 679.1 | 30.4 |
| 1241.24 | 1.49 | 9.5 | 565.0 | 27.1 |

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1500 to 1900 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 1321.32 | 1.50 | 7.9 | 719.2 | 34.6 |
| 1372.14 | 1.57 | 8.0 | 698.2 | 35.7 |
| 1398.32 | 1.56 | 7.8 | 718.4 | 37.3 |
| 1466.08 | 1.42 | 6.8 | 866.4 | 45.0 |
| 1686.30 | 1.90 | 7.9 | 643.9 | 44.5 |
| 1743.28 | 1.83 | 7.4 | 702.5 | 49.3 |
| 1749.44 | 1.72 | 6.9 | 775.5 | 52.9 |
| 1778.70 | 1.89 | 7.4 | 684.6 | 49.7 |
| 1877.26 | 2.18 | 8.1 | 583.2 | 48.0 |
| 2160.62 | 2.09 | 6.8 | 715.1 | 66.4 |
| 2172.94 | 1.80 | 5.8 | 902.0 | 78.1 |
| 2376.22 | 1.86 | 5.5 | 936.7 | 90.2 |
| 2385.46 | 2.44 | 7.2 | 625.9 | 69.3 |
| 2591.82 | 2.80 | 7.6 | 553.2 | 71.3 |
| 2601.06 | 2.53 | 6.8 | 646.4 | 79.5 |
| 2644.18 | 2.21 | 5.9 | 804.8 | 94.0 |
| 2949.10 | 2.61 | 6.2 | 699.4 | 99.0 |
| 3061.52 | 2.58 | 5.9 | 738.8 | 107.9 |
| 3138.52 | 3.98 | 8.9 | 395.3 | 73.5 |
| 4150.30 | 5.09 | 8.6 | 361.4 | 100.6 |
| 4299.68 | 4.86 | 7.9 | 401.3 | 113.0 |
| 4700.08 | 5.41 | 8.1 | 373.5 | 121.3 |
| 8459.22 | 5.81 | 4.8 | 604.0 | 366.0 |
| 21604.66 | 16.02 | 5.2 | 336.9 | 865.8 |
| 22373.12 | 10.26 | 3.2 | 608.8 | 1449.7 |
| 22722.70 | 13.07 | 4.0 | 480.9 | 1173.8 |
| 27267.24 | 15.22 | 3.9 | 459.2 | 1451.6 |
| 29923.74 | 16.11 | 3.8 | 462.8 | 1651.6 |
| 49989.94 | 24.23 | 3.4 | 419.1 | 3064.6 |

Total number of fragments = 694.4

Average ballistic density for all fragments = 694.4

Average gamma for all fragments = 8.219

Number of hazardous fragments in zone = 20

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1900 to 2300 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 346.50 | .66 | 13.3 | 650.7 | 5.4 |
| 934.78 | 1.35 | 10.1 | 595.9 | 19.2 |
| 1039.50 | 1.11 | 7.5 | 888.9 | 28.9 |
| 1410.64 | 1.66 | 8.2 | 659.6 | 35.6 |
| 1895.74 | 2.17 | 8.0 | 593.0 | 49.2 |
| 2125.20 | 1.94 | 6.4 | 786.5 | 69.2 |
| 2159.08 | 2.23 | 7.2 | 648.4 | 62.1 |
| 2177.56 | 2.25 | 7.2 | 645.2 | 62.6 |
| 2919.84 | 2.56 | 6.1 | 712.9 | 99.0 |
| 4305.84 | 2.75 | 4.5 | 944.2 | 200.3 |
| 4874.10 | 5.35 | 7.7 | 393.9 | 131.9 |
| 4883.34 | 3.84 | 5.2 | 703.2 | 194.7 |
| 4935.70 | 4.83 | 6.9 | 465.0 | 149.9 |
| 5021.94 | 5.11 | 7.1 | 434.8 | 146.7 |
| 5802.72 | 4.43 | 5.3 | 622.3 | 225.9 |
| 7830.90 | 6.93 | 6.2 | 429.3 | 262.9 |
| 8080.34 | 7.27 | 6.3 | 410.2 | 264.2 |
| 8739.50 | 7.93 | 6.4 | 391.4 | 286.2 |
| 9928.38 | 6.91 | 4.9 | 546.6 | 423.9 |
| 10627.54 | 10.44 | 6.9 | 315.1 | 321.5 |
| 18178.16 | 15.06 | 5.8 | 311.0 | 652.0 |
| 20275.65 | 15.17 | 5.2 | 343.2 | 805.2 |
| 21184.24 | 12.48 | 4.1 | 480.5 | 1068.5 |
| 22442.42 | 11.06 | 3.4 | 610.2 | 1353.2 |
| 24330.46 | 16.40 | 4.7 | 366.3 | 1072.6 |
| 25659.48 | 13.39 | 3.7 | 521.7 | 1461.1 |

Total number of fragments = 26

Average ballistic density for all fragments = 556.6

Average gamma for all fragments = 6.477

Number of hazardous fragments in zone = 21

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 2300 to 2700 ft

| Fragment Wt. (gr) | Average Presented Area ($in.^2$) | Gamma ($in.^2/lb$) | Ballistic Density ($gr/in.^3$) | Impact Kinetic Energy (ft/lb) |
|---|---|---|---|---|
| 1626.24 | 1.77 | 7.6 | 690.6 | 44.4 |
| 2864.40 | 2.64 | 6.5 | 667.8 | 92.3 |
| 3557.40 | 2.50 | 4.9 | 900.0 | 150.4 |
| 5028.10 | 3.84 | 5.3 | 668.2 | 195.6 |
| 5266.80 | 5.24 | 7.0 | 439.1 | 157.3 |
| 5313.00 | 5.62 | 7.4 | 398.8 | 149.2 |
| 4733.42 | 5.77 | 7.0 | 413.7 | 169.3 |

Total number of fragments = 8

Average ballistic density for all fragments = 617.6

Average gamma for all fragments = 6.984

Number of hazardous fragments in zone = 6

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